CP521

August 2, 1996

Demonstration of Lead-Based Paint Removal From an Historic Wood Structurre Using Laser Technology

Sponsored by: **Environmental Management Division, Kelly Air Force Base, and U.S. Army Corps of Engineers, Fort Worth District**

Performed by: **U.S. Army Construction Engineering Research Laboratories**

Executive Summary

The United States Army maintains thousands of family housing units which were constructed before 1978 and are likely to contain lead-based paint. Chemical paint stripping is often the most appropriate and accepted method for removing lead-based paint from wood surfaces in historic structures. However, chemical stripping is expensive due to containment requirements, the volume of hazardous waste produced and worker protection requirements. In addition, historically significant wood surfaces can be damaged by the chemicals.

The objective of the work performed under this delivery order was to demonstrate the effectiveness of laser stripping technology for the removal of lead-based paint from historic wood surfaces. The test site at Kelly Air Force Base (AFB) was Building 139, an historic structure eligible for the National Register of Historic Places. Both the efficacy of the method and its economic viability were investigated. The lessons learned from this test may allow Kelly AFB and other military activities to increase the efficiency and cost effectiveness of lead-based paint removal technologies appropriate for use on historic structures.

The premise that laser technology could be used to remove lead based paint from historic wood structures was validated. The carbon dioxide (CO_2) laser based paint removal system employed demonstrated several advantages; there are no containment costs, worker protection is not required, hazardous waste is minimized and there is no impact on the environment with this approach. However, the costs of paint removal using the demonstration unit are very high due to the lower power output of the unit and the resultant low production rate. The cost per square foot of paint removed far exceed that of other lead-based paint removal technologies. A more powerful

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 2, 1996	

4. TITLE AND SUBTITLE
Demonstration of a Lead-Based Paint Removal From an Historic Wood Structure Using Laser Technology

5. FUNDING NUMBERS
N/A

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
US Army Construction Engineering Research Laboratories

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
SERDP
901 North Stuart St. Suite 303
Arlington, VA 22203

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
N/A

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release: distribution is unlimited.

12b. DISTRIBUTION CODE
A

13. ABSTRACT ***(Maximum 200 Words)***

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14. SUBJECT TERMS
lead-based paint; paint stripping; paint removal; SERDP; SERDP Collection

15. NUMBER OF PAGES
71

16. PRICE CODE N/A

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
unclass.	unclass.	unclass.	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

commercial laser stripping system needs to be developed in order to make the process competitive on both a cost and rate of removal basis.

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1 Introduction

Background

Paint on historic structures poses a tremendous maintenance problem. Surfaces on old buildings, especially exterior wood siding and trim, often have had many coats of paint applied over 50 or more years. Peeling and alligator cracking may be the result of inflexibility and imperviousness due to excess buildup of paint on the surface. Complete removal of the paint system is usually required to break the cycle of scraping and repainting these surfaces. Paint that contains lead presents added problems. Removal of lead-based paint may be required to protect the health of building occupants, especially where the paint is deteriorating or where the surfaces are subject to friction or impact.

Kelly AFB, in San Antonio, Texas, like other Air Force bases and Department of Defense facilities throughout the United States, has a large inventory of older buildings which have lead-based paint on many surfaces. The Bungalow Colony at Kelly AFB is a family housing area where many structures have thick layers of paint that likely contains lead The bungalow colony is historically significant and is eligible for the National Register of Historic Places.

The bungalow style, originally known as the "California bungalow," became popular in the U.S. in the early 1900's for its simplicity of ornamentation and adaptability of plan. While its origins are reportedly in India, the American interpretation of this small, versatile house was developed by Greene and Greene of Pasadena, California, around 1910. Bungalows were often characterized by a complex roof configuration, verandahs and/or multiple porches, natural materials such as wood, stone or brick, and an appearance of simple functionality.

According to historians at Kelly AFB, the Bungalow Colony was designed and constructed between 1920 and 1928 of salvaged wood from WWI barracks. While most bungalows lacked any but the most functional detailing, the stylistic elements exhibited in the Kelly AFB bungalow community include patterned drop siding, decoratively cut and detailed rafter ends, and gable rakes with exposed rafter ends and deck, simple knee braces, and complex brackets supporting roof projections at gable ends (see Figure 1).

The Kelly AFB bungalows also exhibit battered building skirts, articulated porch supports, exterior chimneys, and wood windows and doors. The houses are sited within a picturesque street plan and the grounds are attractively landscaped.

When lead-based paint must be removed from historic wood structures there are a number of effective methods that may be used; heat guns, vacuum abrasive blasting, conventional abrasive blasting in containment and chemical strippers are some of the best known. Heat guns generate a small volume of hazardous waste, but the process is very labor-intensive.

Figure 1. Bungalow Residence at Kelly AFB

Vacuum abrasive blasting (no containment) or conventional abrasive blasting (100% containment) using an abrasive that includes a chemical stabilizer has been found to successfully remove the lead-based paint while generating a waste classified as non-hazardous, but is often too aggressive a method for use on fragile historic wood structures. Chemical paint stripping is often the most appropriate and accepted method for removing lead-based paint from wood surfaces in historic structures. However, chemical stripping is expensive due to containment requirements, the volume of hazardous waste produced and provisions for worker protection.

Objective

A laser stripping paint removal methodology is now being developed by two U.S. companies, Silicon ALPS (Advanced Laser Processing Systems) Corporation in Santa Clara, California and Tetra Corporation in Albuquerque, New Mexico. The Silicon ALPS demonstration laser paint removal system is designed for use on fragile historic wood structures without damaging the wood. The laser unit has a self-contained waste collection system which is designed to contain the hazardous lead-based paint debris which is produced and reduce worker protection requirements. Prior to its use at Kelly AFB, the laser system had been successfully demonstrated in shop-type applications, but had not yet been demonstrated on-site at a field location. INTA has carried out extensive work on graffiti removal from historic and other structures in San Francisco, CA.

The objective of the work performed under this delivery order was to demonstrate a laser stripping technology for the removal of lead-based paint from historic wood surfaces. The lessons learned from this test may allow Kelly AFB and other military activities to increase the efficiency and cost effectiveness of lead-based paint removal technologies appropriate for use on historic structures.

Initially, this project was to have focused on Building 150, and a renovation plan was requested in order to use the building as a small museum or office for the base historian. That plan is included as part of this report. A decision was subsequently made by the base to rehabilitate Building 139.

Approach

A 60 watt carbon dioxide (CO_2) pulsed laser paint removal system manufactured by Silicon Alps Corporation was selected to remove the lead-based paint from interior and exterior wood surfaces Building 139 at Kelly AFB, TX. This system demonstration unit that was designed to show the potential of laser's capacity to strip a wide variety of materials, including paints, from substrates. Since the rate of paint stripping via laser varies linearly with both energy applied and with thickness of paint to be removed, it can be used to predict the performance by high power production units.

An environmentally compatible paint stripper was selected as the backup technology for use on those surfaces of the building not stripped with the laser system.

2 Renovation Plan

In the original scope of work for this project, USACERL was requested to develop a renovation plan for Building 150 to convert it to a small museum or an office for the Base Historian. Initially, the building was described as a "pilot's quarters," and the plans were to adapt Building 150 as a display of a typical pilot's quarters. It was later determined that the building had indeed been servant's quarters, and that the building's preferred use would be as a conference room for the base contracting office.

Visual analysis of the historic fabric of Building 150 was undertaken, and plans were developed for adapting the building for use as a conference room. A detailed set of specifications for heating, ventilation, air conditioning, electrical and gas supply, and renovation of the historic fabric were prepared. Specifications, floor plans and elevations were submitted to Kelly AFB, via the Army Corps of Engineers, Fort Worth District (as shown in Appendix A). Ft Worth District coordinated concurrence on these plans and specifications from the Texas State Historic Preservation Officer.

At some point after the submission of these plans and specifications, Kelly AFB elected to conduct the laser paint removal demonstrating on Building 139 instead of Building 150. USACERL was not involved in the development of any remodeling plans for Building 139.

3 Description of Technologies

Laser Stripping

The 60 watt laser portable demonstration stripping unit contains all of the necessary equipment required to perform the paint removal. The unit consists of two sections; the top half houses the pulsed 60 watt CO_2 laser and beam delivery system, and the bottom half houses the waste management system, tools and extension hoses. The top and bottom halves can be separated to demonstrate stripping at different heights. The laser may be positioned as required using a fork lift or overhead crane. This laser unit is designed for paint removal from large flat wood surfaces. It did not have a mobile delivery arm. The dimensions of the laser system are 32 1/4" wide x 58 ½" high x 68 1/4" long (Figure 2).

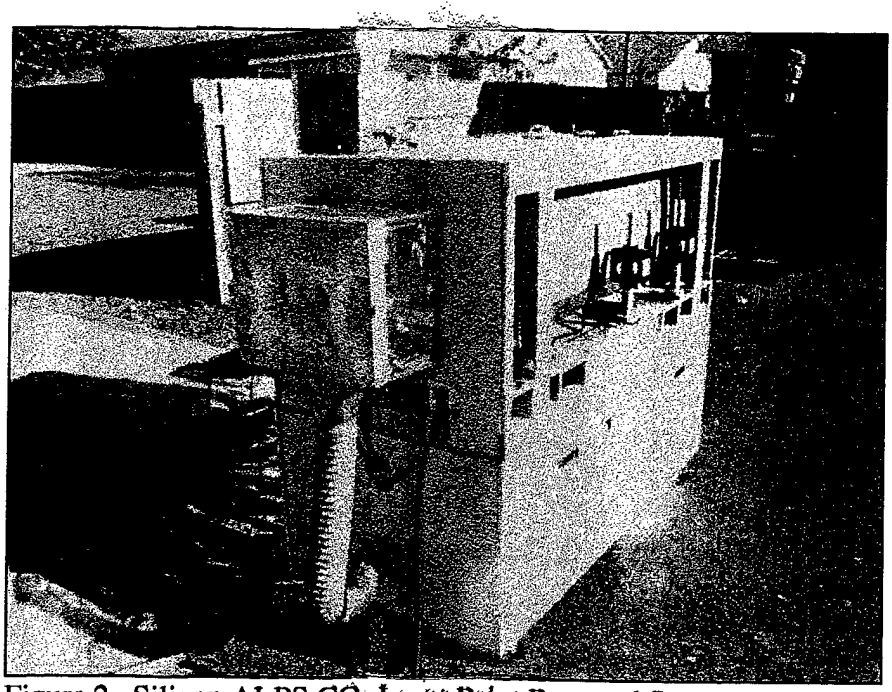


Figure 2. Silicon ALPS CO_2 Laser Paint Removal System

The mirrors and lenses direct the laser light to the target area and homogenize the laser beam to give a uniform energy density footprint of 1 cm^2 in diameter. The design of the optics and the laser beam controller that those footprints overlap in such a way that 100% of the paint is abated without continuing to pulse on those areas (footprints) that have already been stripped, thus preventing any possible damage to the substrate.

The laser is controlled through a multi spectral camera and computer program. The spectrum of each paint color to be removed is stored into the computer memory. The computer instructs the laser to fire at the target when these paint colors are seen by the spectrograph. Thus the laser system can be instructed to remove all coats of paint, or to remove only the top coat(s), leaving the primer intact (when there is a color difference between coats). The camera scans a 11.5 cm x 11.5 cm (4.5 in. x 4.5 in.) frame. The system applies a 5 joule 5 microsecond pulse at each 1 cm^2 target area where necessary, then moves on to the next target area within the "frame". The pulse rate is 10 pps (pulse per second). The laser continues row by row through the frame, then returns to the start of the frame and repeats the process. This restoring process allows each area to cool before being processed again, reducing thermal damage to the substrate. Once the 11.5 cm x 11.5 cm (4.5 in. x 4.5 in.) frame is devoid of any color spectra stored in the computer, the system is moved to a new overlapping frame. Figure 3 shows the raster pattern as seen on the control screen by the system operator.

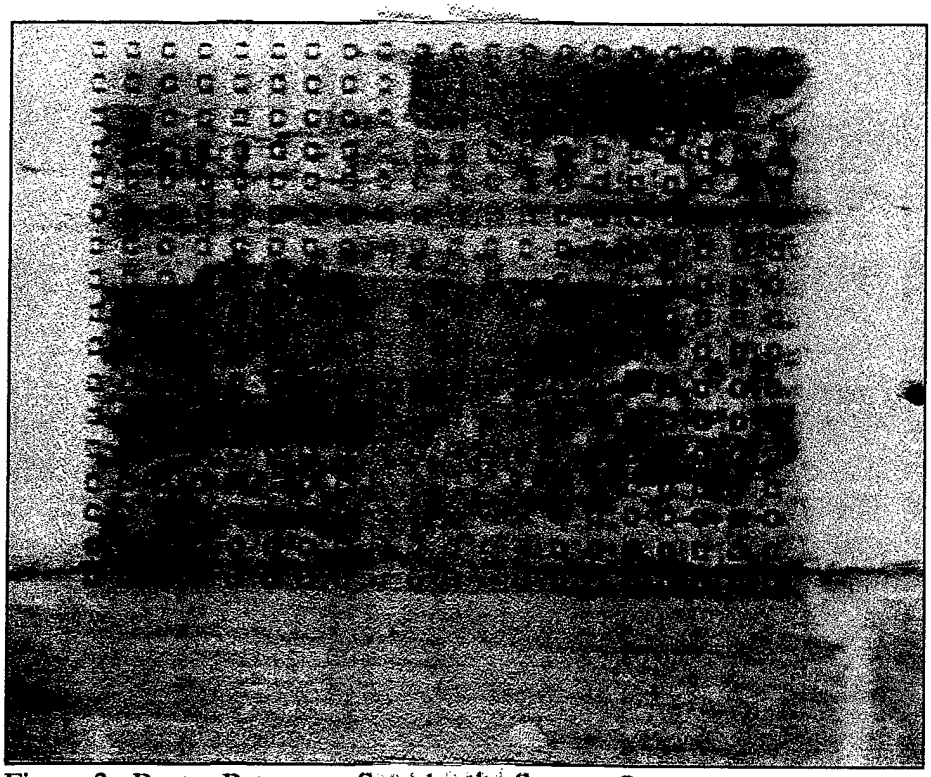


Figure 3. Raster Pattern as Seen by the System Operator

The laser removal system has a fully self-contained waste management system. The stripping chamber is closed on all sides when placed against the wall. A vacuum system collects the waste as it is created. The waste is sent through a waste evacuation tube to a waste processor where it passes first through a high efficiency particulate air (HEPA) filter, and then a carbon filter to remove VOC's (volatile organic compounds). Only oxygen, hydrogen and nitrogen, are released into the atmosphere through an exhaust hose. The particulate matter is captured by the HEPA filter and later placed in storage containers.

Chemical Stripping

Chemical stripping is the most common lead-based paint removal strategy on historic wood structures. In general, on historic properties, the integrity of the existing construction materials (wood) must be preserved where feasible. The *Department of the Interior, Guidelines for Renovation of Historic Places* does not endorse other lead abatement strategies such as removal and replacement of building components, enclosure, encapsulation, and specific paint removal strategies. When done properly, chemical stripping causes no damage to the wood substrate and is the preferred method of paint removal. However, this strategy is expensive and is only used when other less expensive lead abatement strategies are not feasible or allowed. The cost is high due to the volume of hazardous waste generated for disposal, significant labor requirements, as well as OSHA and worker protection regulations.

At Kelly AFB, Nutec Liquid Paint and Varnish Stripper (manufactured by Nutec Industries) was selected to complement the laser stripping. The product contains no toxic methylene chloride or caustic compounds. The Nutec Material Safety Data Sheet (MSDS)[see Appendix B], indicates that the Nutec formula contains acetone, methanol, methyl ethyl ketone, and toluene.

4 Field Demonstration

Preparation of Worker Safety Plans

Prior to commencement of the work, the Contractor (Power Environmental Abatement Technologies, Inc. (PEAT), Buffalo, New York) submitted the following for approval by the USACERL Contracting Officers Representative and Kelly AFB Environmental Management Personnel:

Hazard Communication Program (Appendix C)
Lead-based paint Removal/Abatement Plan (Appendix D)
Respirator Protection Program (Appendix E)
Waste Collection Plan (Appendix F)
Worker Protection Plan (Appendix G)

The submittals were reviewed and approved by:

Certified Industrial Hygienist (CIH), Mr. Stevan W. Pierce, RCI Environmental, Inc., Dallas, Texas.
United States Army Corps. of Engineers, Construction Engineering Research Laboratories
Kelly AFB, Environmental Management Division

Site Description

Building 139 is a simple, 300 ft^2, one-story frame structure located in the Kelly AFB Bungalow Colony. Built in 1942, the structure is constructed on cedar piers set in concrete. The structure has a gable roof covered with asphalt shingles. It is associated with an adjacent officers' quarters and was previously used as a servants' quarters.

Preliminary Testing

To determine the level of lead prior to the commencement of paint removal activities, the surfaces of Building 139 were tested for the level of lead in the paint using an x-ray florescence (XRF) analyzer. Spot checks were conducted on various interior and exterior surfaces throughout Building 139. The XRF instrument used was a Niton unit, model number 309, manufactured by Niton Corporation. The XRF detected lead on the painted surfaces at levels ranging from 0.0 mg/cm^2 to 5.0 mg/cm^2. The results of this testing are summarized in Table 1.

Table 1. Pre-Abatement Summary of XRF Measurements of Lead-based paint

Component	Low Reading (mg/cm^2)	High Reading (mg/cm^2)	Average (mg/cm^2)
Windows	0.7	2.7	1.3
Baseboards	3.4	3.4	3.4
Doors	0.9	5.0	3.5
Exterior Walls	1.1	3.0	2.1
Interior Walls	0.2	0.2	0.2
Overhang	3.2	3.2	3.2

Interior lead dust wipes, as well as the air and worker protection monitoring for this project were conducted by Mr. Greg Upah, Industrial Hygiene Technician, of RCI Environmental, Inc. in Dallas, Texas. Five wipe samples were taken on the interior surfaces of Building 139 prior to the commencement of the work. The laboratory analysis of the wipe samples revealed the presence of lead dust above the guidelines established by the U.S. Department of Housing and Urban Development clearance level for lead dust on a window well of 800 $\mu g/ft^2$ by weight (Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995). The results of these wipe samples are shown in Table 2.

Table 2. Pre-Abatement Lead Surface Wipe Sample Analysis

Sample Date	Sample Type	Sample Location	Analytical Results $\mu g/ft^2$	Clearance Level $\mu g/ft^2$ *
10/31/95	Wipe	North Exterior Wall	224	not established for walls
10/31/95	Wipe	Interior Closet Door	384	not established for doors
10/31/95	Wipe	Interior Window Frame (sill)	20.3	500
10/31/95	Wipe	Interior Window Well	1280	800
10/31/95	Wipe	Interior Floor Surface	203	200

*Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995

Containment

A support platform for the laser unit was constructed at the rear of Building 139 by laying plywood sheets over bricks placed on the ground. Because the waste collection system on the laser stripping unit is designed to collect all lead-based paint particulate in a HEPA filtered vacuum system, it was anticipated that no exterior or interior containment or building protection was needed. However, containment was erected for the laser removal demonstration because it had not yet been demonstrated that the airborne lead levels would not reach OSHA action levels.

Before initiating chemical stripping on the exterior of the building, ground tarpaulins and six mil flame retardant polyethylene sheets were laid down to protect the soil from lead-based paint and/or chemical stripper contamination. Two layers of 20 by 100 foot six mil flame-resistant polyethylene sheets were affixed to the foundation of the building a few feet up from the soil level so that they covered the foundation of the building and extended 15 feet out. Barrier tape and signs were posted in and around the site and on the exterior door. A portion of a fence surrounding the project site was removed in order for the required work to be performed. The containment is shown in Figure 4. The time required for construction of the containment system was approximately two hours for the laser system, and one working day for the chemical stripping.

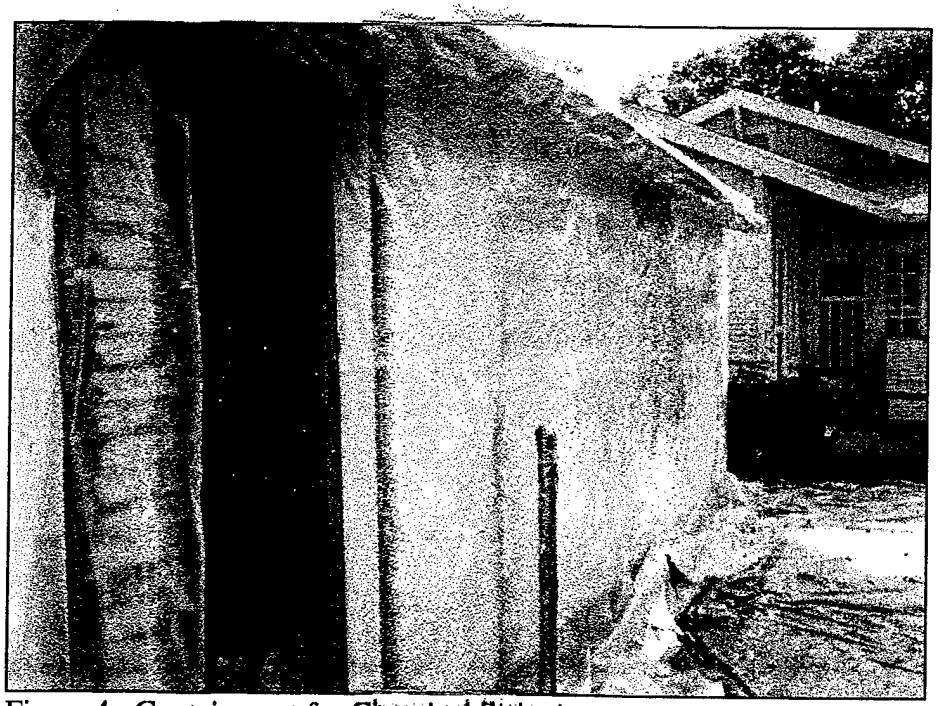


Figure 4. Containment for Chemical Stripping on Building 139

Laser Demonstration - Kelly Air Force Base

Due to vibration during the transportation of the laser machine from Santa Clara, California to Kelly AFB, an small gas leak occurred within the laser unit which could not be detected in the field. A built-in safety feature prevented operation of the unit. Thus the laser machine was inoperative on November 13, 1995, the day of the field demonstration at Kelly AFB. Only after a technician examined the machine on its return to the California laboratory was the gas leak detected and repaired. In order to complete the mission of this project, several lengths of the exterior siding of Building 139 were removed and sent to the California laboratory. All laser stripping was conducted in the laboratory at Silicon ALPS Corporation in Santa Clara, California on January 9, 1996 using original painted wood from Building 139.

Laser Demonstration - Silicon ALPS Corporation

The laser demonstration at Silicon ALPS Corporation consisted of the removal of paint from a 1660.5 square inch wood panel removed from Building 139. The panel was constructed of three clapboards, each approximately 2.75 feet in length. Eight 11.5 cm x 11.5 cm (4.5" x 4.5") test areas were stripped of paint using the laser paint removal system. Because the total area stripped was rather small, all waste was collected in the HEPA filter system.

Test patterns 1-6 were performed on Board No. 1. The six test areas rendered the board clean along its entire length. Surface damage was limited to minor roughening of the surface which was removed by light hand sanding. Paint was not completely removed from test patterns number seven and eight, on boards 2 and 3 respectively. A photograph of a portion of Board No. 1 is shown in Figure 5.

The 60 watt pulsed CO_2 laser was found to remove a total of 1.13 ft^2 of lead-based paint in 255 minutes, or at a rate of 0.27 ft^2/hour. Paint thickness on the boards averaged 30 mils, and thickness varied substantially due to weathering an previous scraping of the paint from portions of the surface.

The theoretical rate of removal of lead-based paint from wood surfaces by a pulsed CO_2 lasers is given by the formula

Rate of removal = [2 ft^2/min]/mil/kW (average power).

Thus, for a 60 watt laser the rate of removal is given by:

Rate of removal = ([2 ft/min]/mil/kW) x 60 minutes x 0.06 KW = 7.2 ft^2/hr/mil thickness.

Thus the 60 watt (0.06 kW) laser should remove a 30 mil thick coating at a rate of 0.24 ft^2 per hour. Because the paint was not completely removed from all the test sections, the experimental removal rate was slightly greater then the projected experimental rate.

The price of paint removal per ft^2 with the 60 watt laser system is much greater than the goal of \$10.00/ft^2, primarily because of the high capital and labor costs per square foot removed. The price per square foot for the field application of the 60 watt laser system to abate a 30 mil thick coating was found to be \$254.00/ft^2, which includes labor, materials, containment, worker protection and profit. A breakdown of the projected costs for the field application of the 60 watt laser unit is shown in Table 3.

Table 3. Projected Price Per Square Foot Calculation - 60 Watt Demonstration Unit

	Per Site/ Week	**Per Site/ Hour**
Capital Facilities*	\$721	\$18.03
Labor	\$1250	\$31.25
Truck/Maintenance	\$337	\$8.43
Consumables (gas & power)	\$10	\$0.25
Environmental Testing (TCLP) and Disposal	\$120	\$3.00
Total	\$2438	\$61.00
Production Rate (ft^2) (For a 30 Mil Thick Coating)	9.6	0.24
Cost per ft^2 = \$254.00 (For a 30 Mil Thick Coating)		

* Based on 8 year amortization schedule with a 40 hour week
System price (2K), \$1.15M
System price (60W), \$0.3 M

** Disposal recovery values > \$0, otherwise add \$1.00 per square foot

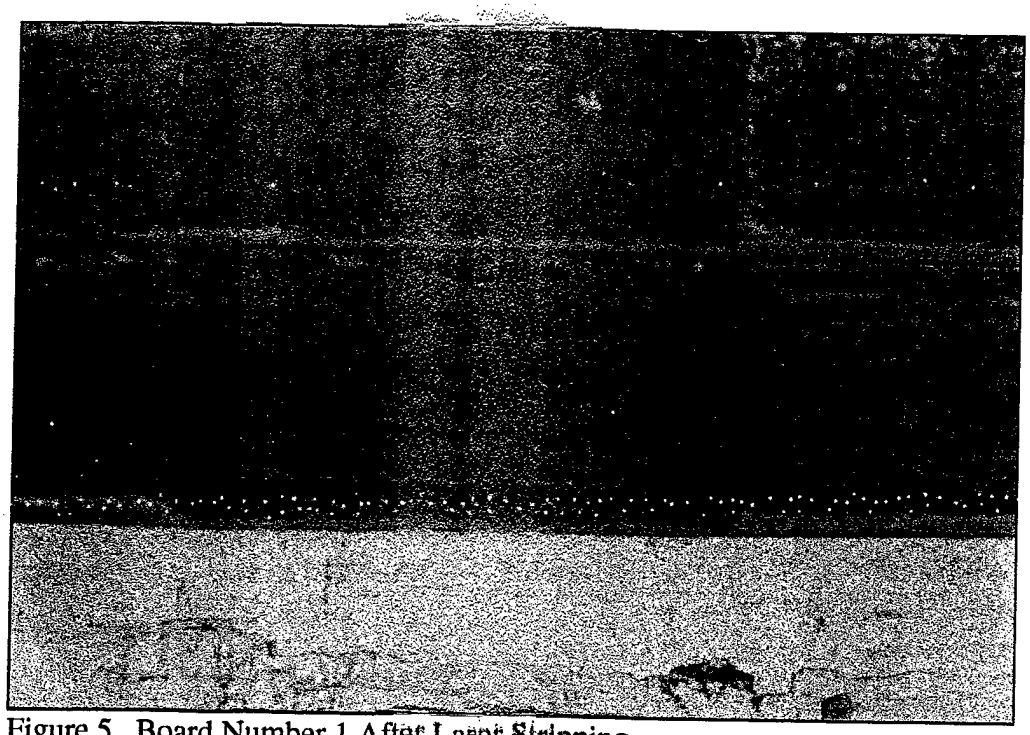


Figure 5. Board Number 1 After Laser Stripping

Chemical Stripping

Chemical paint stripping was used to remove all paint from the exterior overhang and three exterior sides of Building 139. Interior surfaces that were chemical stripped on-site included windows (sashes, sills and casings) and baseboards. The windows panes and a door were sent to a dip stripping operation off-site.

The chemical stripper was applied in gel form and sprayed on until the chemical began to run on the surface. The required dwell time on the surface ranged from two to five hours, depending on the temperature. At seventy degrees Fahrenheit or greater the dwell time was two hours. Cooler temperatures dictated longer chemical dwell time. An average of three chemical applications was required. Sixty-five gallons of chemicals were used with an average stripping rate of 11.45 ft^2/gallon of chemical. The chemical stripping process took nine days to complete.

The price per square foot for the chemical stripping was found to be \$21.90 ft^2 , which includes labor, materials, containment, worker protection and profit . The chemical stripping removal rate was 1.67 ft^2 per labor hour. Four hundred forty-five labor hours were required to chemically strip 744 ft^2 of lead-based paint. Sixty-five gallons of chemical were used and five abatement workers were utilized. The detailed cost data is given in Table 4.

Table 4. Cost Data For Chemical Paint Removal and Component Replacement

Component	**Abatement Method**	**Unit Area**	**Labor Hours**	**Chemical Cost**	**Total Cost**	**Unit Cost**
Exterior Siding	Chemical	530 Ft^2	334	$2073.00	$11,755.93	$22.18/ Ft^2
Exterior Overhang	Chemical	214 Ft^2	111	$677.00	$3918.64	$18.31/ Ft^2
Windows	Dip Stripping	4 windows 7 panes	N/A	N/A	$245.00	$35.00 per pane
Baseboard	Replacement	56	N/A	N/A	$319.20	$5.70/Lf
Interior Door	Replacement	1 door	N/A	N/A	$96.23	$96.23 each
Interior Door	Dip Stripping	1 door	N/A	N/A	$60.00	$60.00 each

Post-Abatement Clearance and XRF Testing

After the paint removal operations were complete, the exterior wood surfaces were tested using the Niton Spectrum Analyzer, model number 309, XRF analyzer. Forty-two XRF tests were completed on the exterior siding and overhang. The XRF readings ranged from 0.00 mg/cm^2 to 1.7 mg/cm^2 . The results of this testing are summarized in Table 5.

Table 5. Post-Abatement Clearance XRF Testing-Exterior, Building 139

Component	**Low Reading (mg/cm^2)**	**High Reading (mg/cm^2)**	**Average Reading (mg/cm^2)**	**HUD Action Level (mg/cm^2)**
Exterior Walls	0.1	1.7	0.41	1.0
Overhang	0.1	0.1	0.1	1.0

The wood which was used for the laser demonstration conducted at Silicon ALPS Corporation was sent to USACERL for x-ray fluorescence (XRF) testing. Three boards were tested using a Scitec XRF analyzer. Each of the boards was 5.5" wide by 32" long. The first board was fully cleaned along its entire length. Test section areas of 11.5 cm x 11.5 cm (4.5" x 4.5") on boards 3 and 4 were cleaned. The results and a description of the condition of the boards after the laser stripping are given in Table 6.

Table 6. Post-Abatement Clearance XRF Testing of Kelly AFB Wood Stripped at Silicon ALPS Corporation

Board Number	**Average Reading (mg/cm^2)**		**Post Abatement Condition**
	Pre-Abatement	**Post-Abatement**	
1 full board length cleaned (2.75 feet)	na	0.2	smooth and visibly free of paint
2 one 4.5" x 4.5" test pattern cleaned	11.7	0.7	rough, darkened, and uneven - removal incomplete
3 one 4.5" x 4.5" test pattern cleaned	15.4	1.1	rough, darkened, and uneven - removal incomplete

After all lead-based paint abatement was completed, the interior surfaces of Building 139 were cleaned with a HEPA-filtered vacuum and wiped down with a five percent (5%) tri-sodium phosphate solution. Surface dust wipe samples were taken to determine if the building was "lead safe" per HUD guidelines.

The laboratory analysis of the five surface wipe samples collected on November 13, 1995 revealed lead dust contamination levels above the clearance levels established in the HUD Guidelines: 200 $\mu g/ft^2$ for floor surfaces, 500 $\mu g/ft^2$ for window sills, and 800 $\mu g/ft^2$ for window troughs. The results are presented in Table 7.

After additional cleaning, laboratory analysis of the three surface wipe samples collected on November 18, 1995 revealed the lead dust contamination level on the window trough surface remained above the 800 $\mu g/ft^2$ clearance level. The analytical results of the second clearance

wipe samples are given in Table 8. Due to deterioration of the wood substrate at this location, a rough surface texture developed over the years and the window trough could not be cleaned to meet HUD guidelines. The window trough was replaced, and at that point all surfaces measured below the clearance level.

Table 7. Post Abatement Building 139 Initial Lead Surface Wipe Sample Analysis Results

Sample Date	**Sample Type**	**Sample Location**	**Analytical Results**	**Clearance Level***
11/13/95	Wipe	South Exterior Wall	960 $\mu g/ft^2$	not established
11/13/95	Wipe	Interior Closet Frame	94.4 $\mu g/ft^2$	not established
11/13/95	Wipe	Interior Window Sill	3150 $\mu g/ft^2$	500 $\mu g/ft^2$
11/13/95	Wipe	Interior Window Well	925 $\mu g/ft^2$	800 $\mu g/ft^2$
11/13/95	Wipe	Interior Floor Surface	679 $\mu g/ft^2$	200 $\mu g/ft^2$

*Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995

Table 8. Post Abatement Building 139 Lead Surface Wipe Sample Analysis Results

Sample Date	**Sample Type**	**Sample Location**	**Result**	**Clearance Level***
11/18/95	Wipe	Interior Window Sill	359 $\mu g/ft^2$	500 $\mu g/ft^2$
11/18/95	Wipe	Interior Window Well	1430 $\mu g/ft^2$	800 $\mu g/ft^2$
11/18/95	Wipe	Interior Floor Surface	<1.6 $\mu g/ft^2$	200 $\mu g/ft^2$

*Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995

Worker Protection/Air Monitoring

The laser beam optics are completely enclosed except at the work surface. Worker protective clothing and respirators are not required during abatement using the laser system. Protective lenses are worn by the laser technician as a safety precaution only. In contrast, the chemical stripping required gloves, disposable coveralls, and eye and respiratory protection.

Laboratory analysis of the personal breathing zone air samples revealed that the workers in the abatement confinement area during use of the laser system at Silicon ALPS Corporation were not exposed to lead dust in excess of the personal exposure level (PEL) respiratory protection equipment criteria of 500 g/m^3 for half-face negative pressure cartridge respirators for lead-based paint abatement personal protect as required by 29 CFR 1926.62(f)(2)(I). The time weighted average exposure level calculations based on the laboratory analysis of the collected samples are as given in Table 9.

Table 9. Personal Breathing Zone Lead Exposure Results - Laser Stripping

Sample Date	**Sample Type**	**Sample Location**	**Monitoring Time Span**	**Time Weighted Average**
1/9/96	Abatement Process	Breathing Zone	286 minutes	<3.0 ug/m^3
1/9/96	Abatement Process	Containmen t Area	287 minutes	<3.0 ug/m^3

Laboratory analysis of the collected area air samples revealed that exposure to lead did not exceed the action level of thirty miccrograms per cubic meter (as established by 29 CFR 1910.1025) during the laser demonstration activities at Silicon ALPS Corporation. The air monitoring results are given in Table 10.

Table 10. Environmental Lead Exposure Results - Laser Stripping

Sample Date	**Sample Type**	**Sample Location**	**Air Volume Collected**	**Analytical Results**
1/9/96	CEF Abatement	Breathing Zone	572 Liters	<3.0 ug/m^3
1/9/96	CEF Abatement	Laser Head	574 Liters	<3.0 ug/m^3
1/9/96	CEF Abatement	Laser Filter Exhaust	574 Liters	8.0 ug/m^3

The workers performing the chemical stripping were protected from inhalation of or contact with the chemical and the lead-based paint . Tyvek overalls were worn to protect the workers' skin, along with plastic gloves, eye protection and half-facepiece negative pressure cartridge respirators.

Laboratory analysis of the personal lead dust air monitoring samples collected by RCI Environmental, Inc., revealed that the workers within the containment area during the paint stripping activities were not exposed to lead dust in excess of the eight hour time weighted average (TWA) respiratory protection equipment criteria of 500 $\mu g/m^3$ for half-facepiece negative pressure cartridge respirators as presented in 29 CFR 1926.62(f)(2)(I). The time weighted average exposure level calculations based on the laboratory analysis of the collected samples are given in Table 11.

Table 11. Personal Breathing Zone Lead Exposure Results - Chemical Stripping

Sample Date	**Sample Type**	**Sample Location**	**Monitoring Time Span**	**Time Weighted Average**
10/31/95	Abatement Process	Breathing Zone	104 minutes	<7.0 ug/m^3
10/31/95	Abatement Process	Breathing Zone	132 minutes	1.65 ug/m^3
11/01/95	Abatement Process	Breathing Zone	290 minutes	38.06 ug/m^3
11/01/95	Abatement Process	Breathing Zone	292 minutes	25.55 ug/m^3
11/08/95	Abatement Process	Breathing Zone	203 minutes	16.92 ug/m^3
11/08/95	Abatement Process	Breathing Zone	203 minutes	13.11 ug/m^3

Laboratory analysis of the collected air samples revealed that the levels of lead in the air outside the control area did not exceed the action level of thirty (30) micrograms per cubic meter of air ($\mu g/m^3$), as established by 29 CFR 1910.1025, during the chemical removal of lead-based paint on days that the activities were monitored. The air monitoring results are shown in Table 12.

Table 12. Environmental Lead Exposure Results - Chemical Stripping

Sample Date	Sample Type	Sample Location	Air Volume Collected	Analytical results
10/31/95	CEF Abatement	South Side Downwind	5400 Liters	<0.3 ug/M^3
11/01/95	CEF Abatement	South Side Downwind	3600 Liters	<0.4 ug/M^3
11/08/95	CEF Abatement	South Side Downwind	5572 Liters	0.7 ug/M^3

Waste Handling

Three barrels of hazardous waste were generated during chemical stripping on Building 139. This waste consisted of paint chips, chemical residue, and personnel protective equipment and clothing. The waste was handled and disposed of in accordance with all Federal, state, and local regulations. The Kelly AFB Environmental Management Division was the generator of record. The waste was disposed of through the installation's contract with Laidlaw Environmental and the cost was invoiced back to the subcontractor. The waste was then taken to Hydrocarbon Recyclers, Inc., San Antonio, Texas.

Very little waste was created by the laser stripping demonstration due to the small surface area that was laser stripped. Since the waste was caught by the HEPA filter with a remaining useful life, the waste was not disposed of at this time.

5 Potential Future Developments In Laser Paint Removal Systems for Lead Paint Removal

A prototype production laser paint stripping unit has recently been acquired by the U.S. Army, in Corpus Christi, Texas, for removal of paint from helicopter rotor blades. This prototype unit has a pulse rate which is thirty-three times faster than the laser demonstration unit used at Kelly AFB, and a raster pattern which is 12" X 12". A technical comparison of the proposed 2000 watt prototype laser system and the 60 watt system used in this study is given in Table 13. The prototype unit has the potential to be adapted for stripping paint from historic wood structures.

Table 13. Comparison of Demonstration Laser Unit and the Future Production Laser Unit

	Demonstration Unit	**Future Production Unit**
Avg. Power (W)	60	2000
Pulse Width (μs)	5	0.5
Pulse Energy (J)	5	8
Energy Density (J/cm^2)	5	5
Peak Power Density (Mw/cm^2)	1	10
Pulse Reproduction Rate (Hz)	10	250
Wavelength (μm)	10.6	10.6
Foot print area (cm^2)	1.0	1.6
Frame Size	4.5" X 4.5"	12" X 12"
Average Thickness Of Material Removed Per Pulse (mil)	0.3	0.3
Rate of Removal of a 1 Mil Thick Coating (ft^2/hour)	7.2	240
Rate of Removal of a 30 Mil Thick Coating (ft^2/hour)	0.24	8
Cost per ft^2 for removal of a 30 mil thick coating	$254.00	$14.50

Based on the formula for the rate of removal of paint from most surfaces, including lead-based paint on wood [rate of removal = 2 ft^2/min/mil/kW (average power)] the 60 watt (0.06

kW) laser will remove a 1 mil thick coating at a rate of 7.2 ft^2 per hour at a cost of $254.00 (as shown earlier in Table 3).

A 2000 watt (2 kW) laser would remove a 1 mil thick coating at a rate of 240 ft^2/hour,(a rate thirty-three times faster than the 60 watt laser) and lower the cost to $14.50/$ft^2$ (Table 14).

The actual cost per ft^2 for removing thick layers of lead-based paint using the proposed 2 kW unit would range between $11 and $15 ft^2. A detailed breakdown of how this price per square foot for both the 60 watt and 2000 watt prototype laser was derived is given in Table 14 respectively.

Table 14. Projected Price Per Square Foot Calculation - 2000 Watt Production Unit

	Per Site/ Week	**Per Site/ Hour**
Capital Facilities *	$2747	$68.70
Labor	$1250	$31.25
Truck/Maintenance	$337	$8.43
Consumables (gas & power)	$144	$3.60
Environmental Testing (TCLP) and Disposal**	$120	$3.00
Total	$4598	$115.00
Production Rate (ft^2) (For a 30 Mil Thick Coating)	320	8
Cost per ft^2 = $14.50 (For a 30 Mil Thick Coating)		

* Based on 8 year amortization schedule with a 40 hr week
System price(2K), $1.15M
System price(60W), $0.3M

** Disposal recovery values >$0, otherwise add $1.00 per square foot

6 Conclusions and Recommendations

Conclusions

1. The laser stripping process was demonstrated to be successful at removing lead-based paint from historic wood structures as shown by the post abatement clearance XRF data in Tables 5 and 6. The process is a clean removal technology without any need for environmental containment and worker protection requirements as shown by personal and environmental air monitoring data in Tables 9 and 10. The waste is comprised of only paint particles, which greatly minimizes the volume of hazardous waste.

2. The theory and application of laser paint stripping for use on historic wooden structures was validated. However, the application of a low power (60 watt) CO_2 pulsed laser stripping system is neither time effective or economically feasible. The potential of the technology lies with a faster, more powerful laser system of at least 2000 watts average power for a CO_2 pulsed laser system or a Nd YAG type laser system, or a combination of both.

3. The demonstration cost to remove a 30 mil coat of paint with the 60 watt laser was nearly \$254.00 or 25 times greater than the goal of \$10.00/ft^2. This extreme cost was due to the slow removal rate of the demonstration unit as well as the high cost of the laser unit and its operation. A faster,more powerful laser can reduce this cost greatly. A prototype laser for paint removal from helicopter blades is 33 times faster than the demonstration unit and will remove paint at a cost of approximately \$14.50/ft^2 (for a 30 mil thick coating). This 2 KW laser, if designed for lead-based paint removal from wood structures, would bring the cost down to between \$11 and \$15 per square foot. This price is extremely competitive when compared to chemical paint strippers. The removal cost per square foot will increase in proportion to the paint thickness, because each pulse of the laser removes just .3 mils of paint. As a result, thick paint will always take longer and be more costly to strip than thin paint. These cost estimates are based on a 30 mil thick coating system (the average thickness encountered in this demonstration), an amortization time for the capital cost of 8 years and the system operated 40 hours per week. Since the useful life of the system is expected to be greater then 10 years, the schedule used is conservative. Note, that after the systems cost is fully system is amortized the cost of paint removal drops to \$6/ft^2.

4. The chemical stripping removed the lead-based paint at a cost of \$21.06, a typical cost for lead-based paint removal from a historic structure. Containment and worker protection requirements were needed. A substantial volume of hazardous waste was created for the small amount of area that was stripped.

5. Laser stripping may reduce some of the hidden costs associated with the current lead-based paint removal methods. These hidden costs include, but are not limited to, occupant relocation expenses during abatement, possible floor covering replacement, damages caused

by chemical strippers, etc.

Recommendation

1. Adaptation and further development of the more powerful laser system is recommended in order for the laser paint removal systems to become competitive with more conventional lead based paint abatement technologies.

Vincent Hock
Principal Investigator
USACERL

Susan Drozdz
Principal Investigator
USACERL

Virge Temme
Principal Investigator
USACERL

Appendix A - Renovation Plan for Building 150

1. These plans and general specs are to be added to and provided with all other COE documentation currently in place for building #151, KAFB, San Antonio, TX.

2. Each Contractor shall have public liability, property damage, and workman's compensation insurance or as noted in COE guidance.

3. Each Contractor shall figure a complete job, including all miscellaneous items needed to complete each phase, normal to 'Good Workmanship'.

4. All work is to be in accordance with all applicable codes and ordinances.

5. Should any discrepancies, errors, conflicting items or clarifications be discovered in plans and or specifications, the contractor shall notify the appropriate Army Corps of Engineers project staff before proceeding with work.

6. All dimensions shall be field verified.

7. Patch and repair all existing finishes to match. Repair any finishes damaged during construction.

8. Contractor is responsible for keeping a clean and safe jobsite. Safety and quality control methodology shall follow standard COE guidance.

9. Each Contractor shall visit the site and verify all existing conditions before submitting a bid proposal.

10. Color selections are to be submitted for owners approval.

Demolition

1. Plumbing
   - remove existing lav fixtures in office spaces
   - remove existing water heater, flue and all water, electrical and gas connections
   - remove existing shower and all related water and drain piping
   - remove existing radiator piping (radiators are to remain)

2. Electrical
   - remove existing fixtures
   - remove existing wall mounted outlets

3 General
   - remove all existing masonite upper wall and ceiling system
   - remove wood shelf above existing water heater

Revision dated -10 April 1995

Carpentry

1. Exterior
    - Windows
        - inspect and repair or replace all glass, putty, or required caulk areas
        - verify all existing screen and storm windows, repair damage and replace all missing to match existing
        - remove each sash and install new vinyl weather-stripping and replace stop (match existing)
        - inspect all window hardware - replace where required - to match existing
        - install new ① window **and door** flashing at all locations - **to match existing** ①
    - inspect trim and siding - replace all rotted, missing or non - repairable pieces
        - **repair split, chipped or rotted pieces with Abatron epoxy fill, sanded and shaped to match existing profile** ①
    - remove all existing exterior doors - rehang repaired doors and strip, clean and repair existing hardware
    - **install** screen doors **(2)** to match **existing on bldg # 149** ①
    - **remove base course of siding at skirt area. replace metal flashing, replace insect screens and modify pertinent trim bds to conform** ①
    - **Stairs**
        - **remove existing wood steps** ①
        - **excavate and pour 4" concrete pad at base w/ 6x6 10/10 wwm on minimum 4" gravel base** ①
        - **replace existing wood steps - match existing size, species and shape - use treated lo. if available** ①
2. Interior
    - remove existing window treatment and hardware and install period replacement (as per COE guidance) venetian blinds
    - inspect existing flooring - replace all rotted or non - repairable pieces and refinish (to match existing)
    - install new toilet accessories to match existing
    - install new mechanical room door and hardware to match existing
    - remove all existing interior doors and stop - rehang repaired doors and strip, clean and repair existing hardware
    - inspect existing interior woodwork - replace all rotted, missing or non - repairable pieces and refinish (to match existing)
    - install new masonite **panels** and lattice **strapping** upper wall and ceiling system to match existing - to paint ①

① Revision dated -10 April 1995

Finishes

1. Paint
    - trim/woodwork - use oil based primer and 2 finish coats paint(latex) as per COE guidance
    - walls - prime and 2 finish coats as per COE guidance
    - floor - use floor grade primer (oil based) and paint or polyurethane (latex) -prime, 2 finish coats as per COE guidance
    - **all paint is to be Pratt and Lambert** [1]
    - **Kelly CE POC: R. E. Aubrey for paint specs**[2]
2. Flooring
    - **Mechanical Room**
        - install VCT tile over 1/4" luan plywood subfloor with metal transition bar
    - **refinish existing wood flooring (see paint spec) all other spaces** [1]
3. Hardware
    - match existing hardware (brass) and finishes

[1] **Revision dated -10 April 1995**
[2] **Revision dated 3 May 1995**

Finishes

1. Paint
   - trim/woodwork - use oil based primer and 2 finish coats paint(latex) as per COE guidance
   - walls - prime and 2 finish coats as per COE guidance
   - floor - use floor grade primer (oil based) and paint or polyurethane (latex) -prime, 2 finish coats as per COE guidance
   - **all paint is to be Pratt and Lambert** ①
2. Flooring
   - **Mechanical Room**
     - install VCT tile over 1/4" luan plywood subfloor with metal transition bar
   - **refinish existing wood flooring (see paint spec) all other spaces** ①
3. Hardware
   - match existing hardware (brass) and finishes

① Revision dated -10 April 1995

Mechanical Notes

1. All work shall conform to local codes. Mechanical Contractor shall execute all work in a workmanlike manner, in accordance with the generally established standards in the industry. It is the Mechanical Contractor's responsibility to install all equipment in a manner that it can be easily serviced.

2. Mechanical Contractor is responsible for providing a fully functional forced air heating and cooling system. Bid documents are diagrammatic in nature. If items essential to providing a fully functional systems are not explicitly shown in the bid documents, Mechanical Contractor is not relieved from the responsibility of providing these items. In the event that items essential to the system are not shown in these documents, Mechanical Contractor shall notify the Government Contracting Representative and include said items in the bid.

3. Mechanical Contractor shall install one ceiling mounted exhaust fan in the bathroom . Mechanical Contractor shall run duct from fan through roof and terminate with roof cap conforming to local codes and in a manner satisfying historical preservation officials.

4. Mechanical contractor shall install rectangular ductwork (sheet metal or rigid fiberglass type) as shown on the plans. All sheet metal ductwork shall be insulated with a minimum of 1" thick fiberglass duct insulation and shall conform to SMACNA standards. All fiberglass type ductwork shall be fabricated and installed according to Thermal Insulation Manufacturers' Association (TIMA) standards.

5. All flex duct shall be insulated with a minimum of 1" fiberglass. All flex duct connections to rectangular ductwork shall have locking volume dampers.

6. All supply ductwork shall be installed in the crawl space, hung from the building structure. Mechanical Contractor shall coordinate exact grille and diffuser locations with Government Contracting Representative.

7. Mechanical Contractor shall provide and install forced air heat pump meeting the following specifications:

- Vertical downflow type heat pump air handling unit with gas-fired back-up;
- Nominal Heating Capacity = 20,000 BTUH
- Nominal Cooling Capacity = 24,000 BTUH
- 800 cfm @ 1.5" E.S.P., fan HP=0.5, minimum AFUE=0.90, minimum SEER=12.0, with disposable filter.
- Mechanical Contractor shall provide and install supply and return plenums of sufficient size to connect supply and return as per plan.
- Mechanical Contractor is responsible for supplying and installing condensate drain to an exterior splash block near AC condensing unit.

8. Mechanical Contractor shall install exhaust flue from gas furnace through the roof, terminating in an approved manner above the roof (use existing roof opening). If forced draft is used for combustion air, Contractor shall draw combustion air from crawl space below building.

Plumbing Notes

1. All work shall conform to local codes. Plumbing Contractor shall execute all work in a workmanlike manner, in accordance with the generally established standards in the industry. It is the Plumbing Contractor's responsibility to install all equipment in a manner that it can be easily serviced.

2. Plumbing Contractor is responsible for providing fully functional water and drain/waste/vent systems. Bid documents are diagrammatic in nature. If items essential to providing a fully functional systems are not explicitly shown in the bid documents, Plumbing Contractor is not relieved from the responsibility of providing these items. In the event that items essential to the system are not shown in these documents, Plumbing Contractor shall notify the Government Contracting Representative and include said items in the bid.

3. Plumbing Contractor shall demolish **and remove** all existing plumbing (water heater, lavatory, shower water pipes and lavatory drain **- provide and install:** ①

- **lav** **reporcelain exist. lav - refurbish/reinstall -white** ①
- **lav fixture** **Kohler**
- **toilet** **Kohler** **Nostalgia 1.5-#4065** **white w/ white Kohler** ① **seat to match** ①
- **water heater State** **SCI-2-1SUS4-K** **120v - 2gal** ①

4. Plumbing Contractor shall install new fixtures listed in attached "cut sheets" (or equal), including point-of-use water heater. Install water heater on **steel** shelf in mechanical closet. Provide galvanized sheet metal drain pan under water heater, with pan drain line connected to air conditioning condensate drain. ①

① Revision dated -10 April 1995

Electrical Notes

1. All work shall conform to local codes. Electrical Contractor shall execute all work in a workmanlike manner, in accordance with the generally established standards in the industry. It is the Electrical Contractor's responsibility to install all equipment in a manner that it can be easily serviced.

2. Electrical Contractor is responsible for providing fully functional electrical system. Bid documents are diagrammatic in nature. If items essential to providing a fully functional systems are not explicitly shown in the bid documents, Electrical Contractor is not relieved from the responsibility of providing these items. In the event that items essential to the system are not shown in these documents, Electrical Contractor shall notify the Government Contracting Representative and include said items in the bid.

3. Verify capacity of existing electrical service. If required, remove existing service and provide new 100A, 20 circuit panel per National Electric Code **(bid as alternate #1).** ①

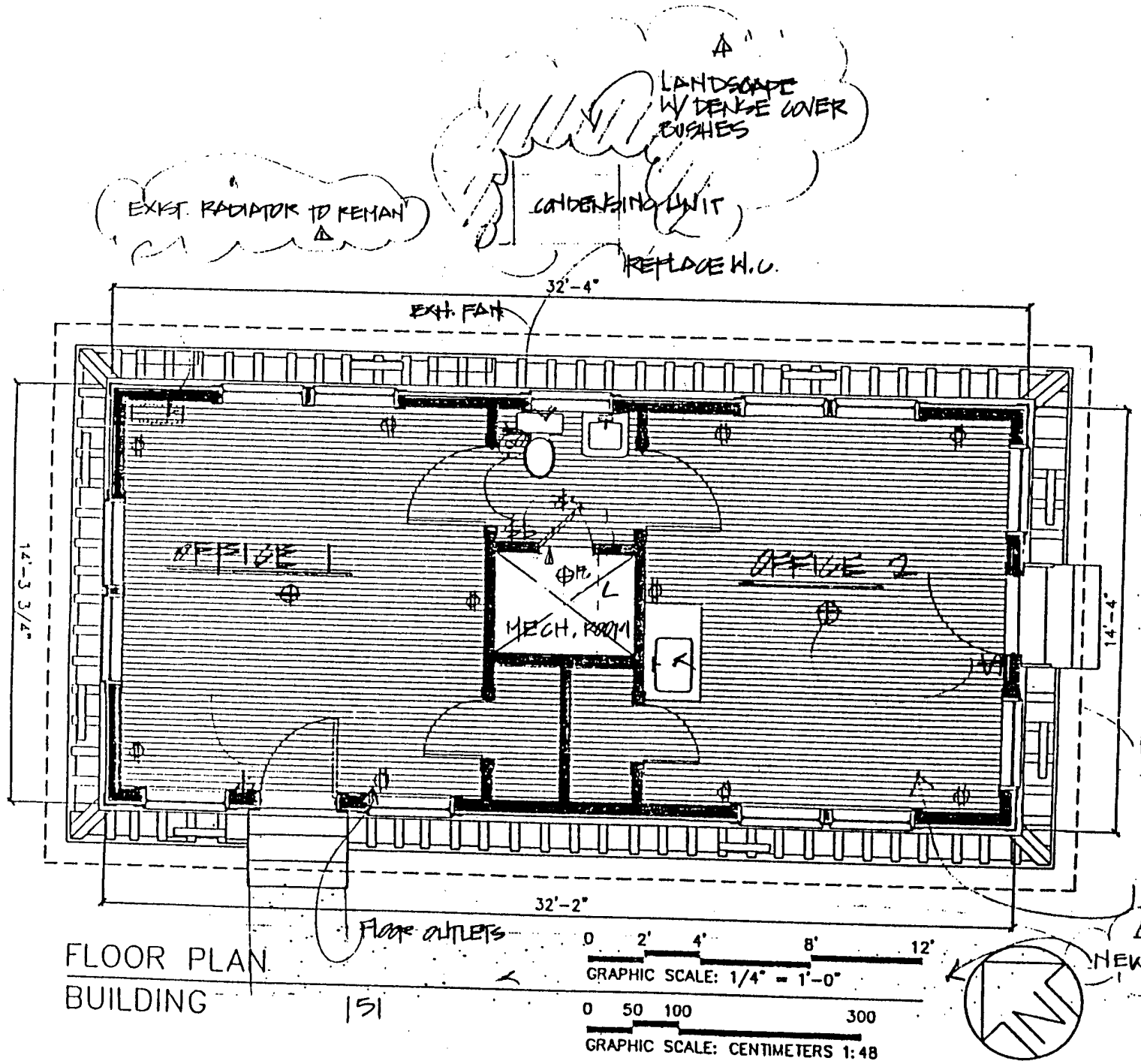
4. Remove existing exposed conduit and outlet receptacles and install new floor mounted outlets as per plan.

5. Remove existing electrical fixtures - provide and install:

• Exterior Entry Fixtures	2	Progress	P5666-31	Black-stop side mount ①
• Office Spaces	2	Angelo Bros	81529	center in space ①
• Toilet Rm.	1	Progress	P3415-30	2-60w , center in space ①
• **exhaust fan**	1	**50 cfm - low sone type**		**exhaust to exterior ①**
• Mechanical **Room**	1	PC Porcelain base w/ 30w fluorescent ①		

① Revision dated -10 April 1995

ATTACHMENT "B"



FLOOR PLAN
BUILDING 151

REMOVE EXIST. SHOWER
- INSTALL VCT FLOOR (SEE NOTES)
- INSTALL NEW DOOR (5 PANEL TO MATCH)
- INSTALL SILL W/ SHELF (±5" AFF)
- REMOVE THRESHOLD

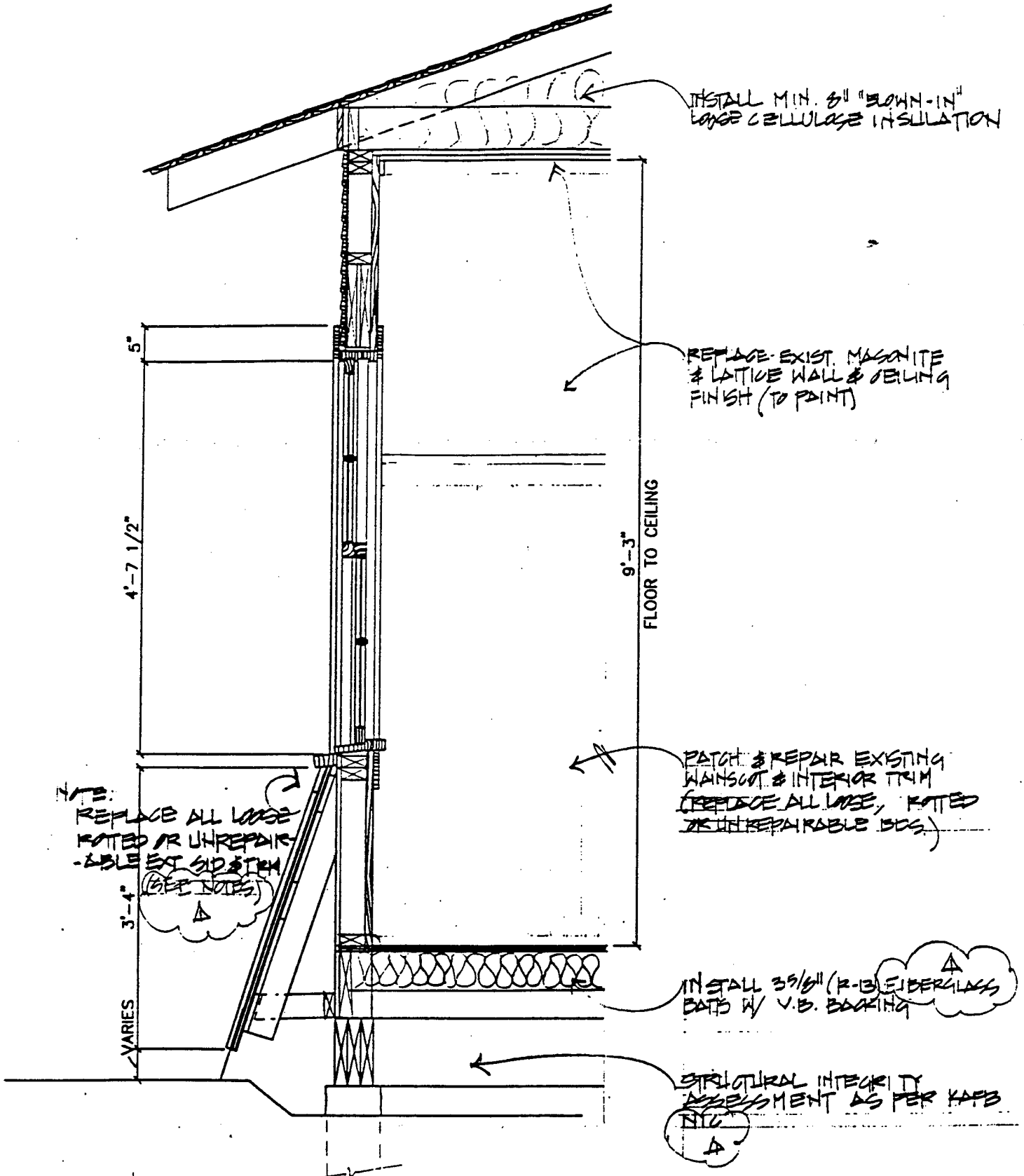
REMOVE SINK

REFINISH FLOOR (WOOD)

NEW CONC. WALK

1 REVISED 4/13/95

A1



EXISTING WALL SECTION

0 1' 2' 4'

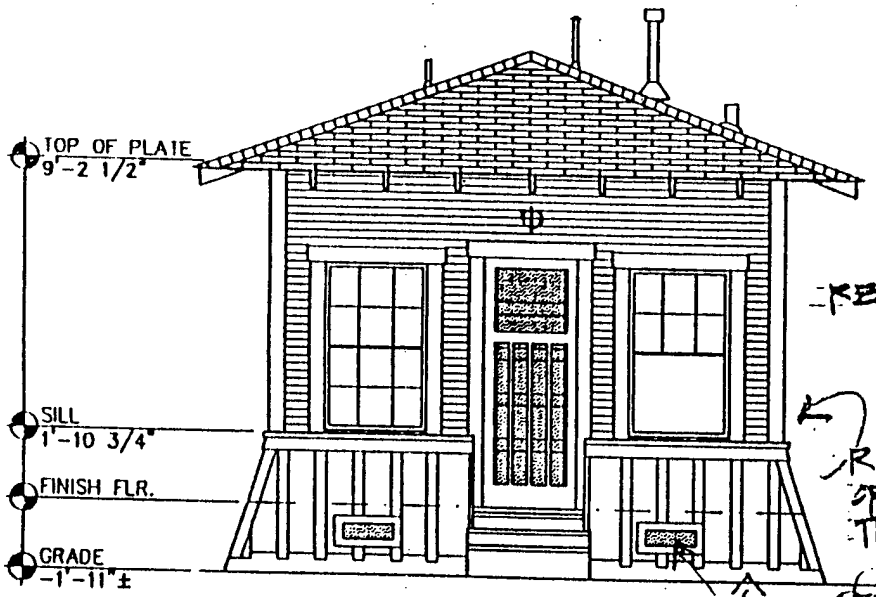
GRAPHIC SCALE: 3/4" = 1'-0"

0 50 100

GRAPHIC SCALE: CENTIMETERS 1:16

A2

5/4/4 REVISED



REPAIR WINDOWS (SEE NOTES)

REPLACE MISSING OR UNREPAIRABLE TRIM & SIDING (SEE NOTES)

REPLACE SILL FLASHING & VENT SCREENING

0 2' 4' 8' 12'

GRAPHIC SCALE: 1/4" = 1'-0"

0 50 100 300

GRAPHIC SCALE: CENTIMETERS 1:48

ELEVATION – SOUTHEAST ELEVATION

BUILDING #149 (SIM. BLDG. 151)

REV 4/13/95

A3

ELEVATION – SOUTHWEST ELEVATION

BUILDING #149 (SIM. BLDG 151)

GRAPHIC SCALE: 1/4" = 1'-0"

0 50 100 300

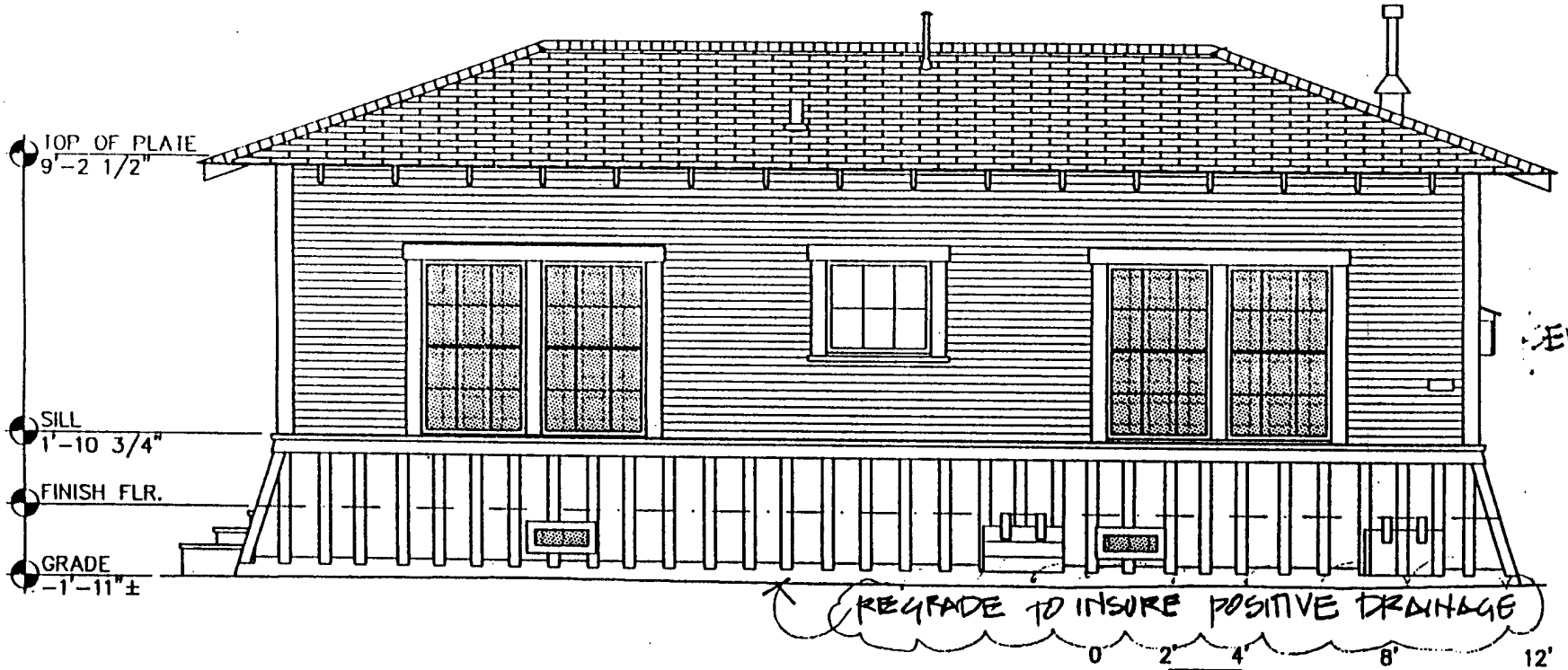
GRAPHIC SCALE: CENTIMETERS 1:48

MATERIALS:

FOUNDATION: THREE 2x10'S ON STONE WITH 2x10 JOISTS
WALLS: DROP SIDING ON 2x4'S
SKIRT: WOOD WITH 1x4 BATTENS, METAL FLASING AR BASE
ROOF: ASPHALT SHINGLES

REV. 4/13/95

A4

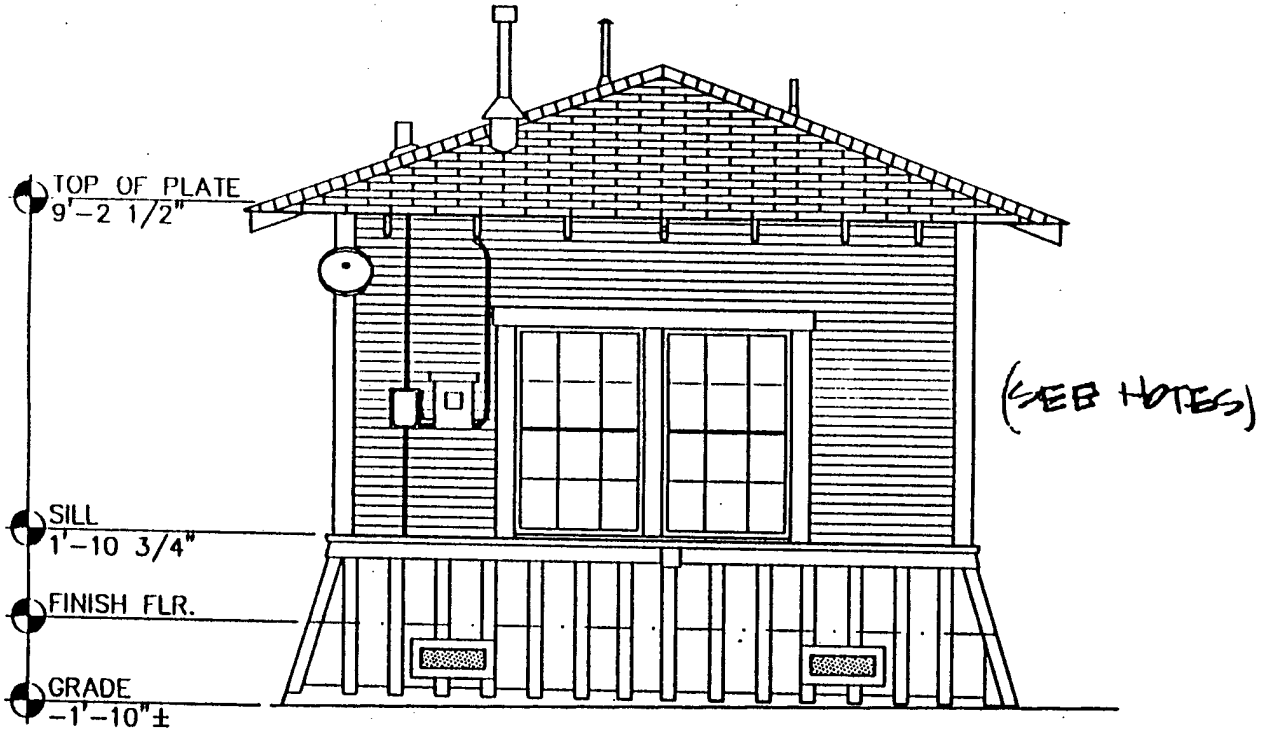


ELEVATION – NORTHEAST ELEVATION

BUILDING #149 (SIM. BLDG. 151)

REV. 4/15/95

A5



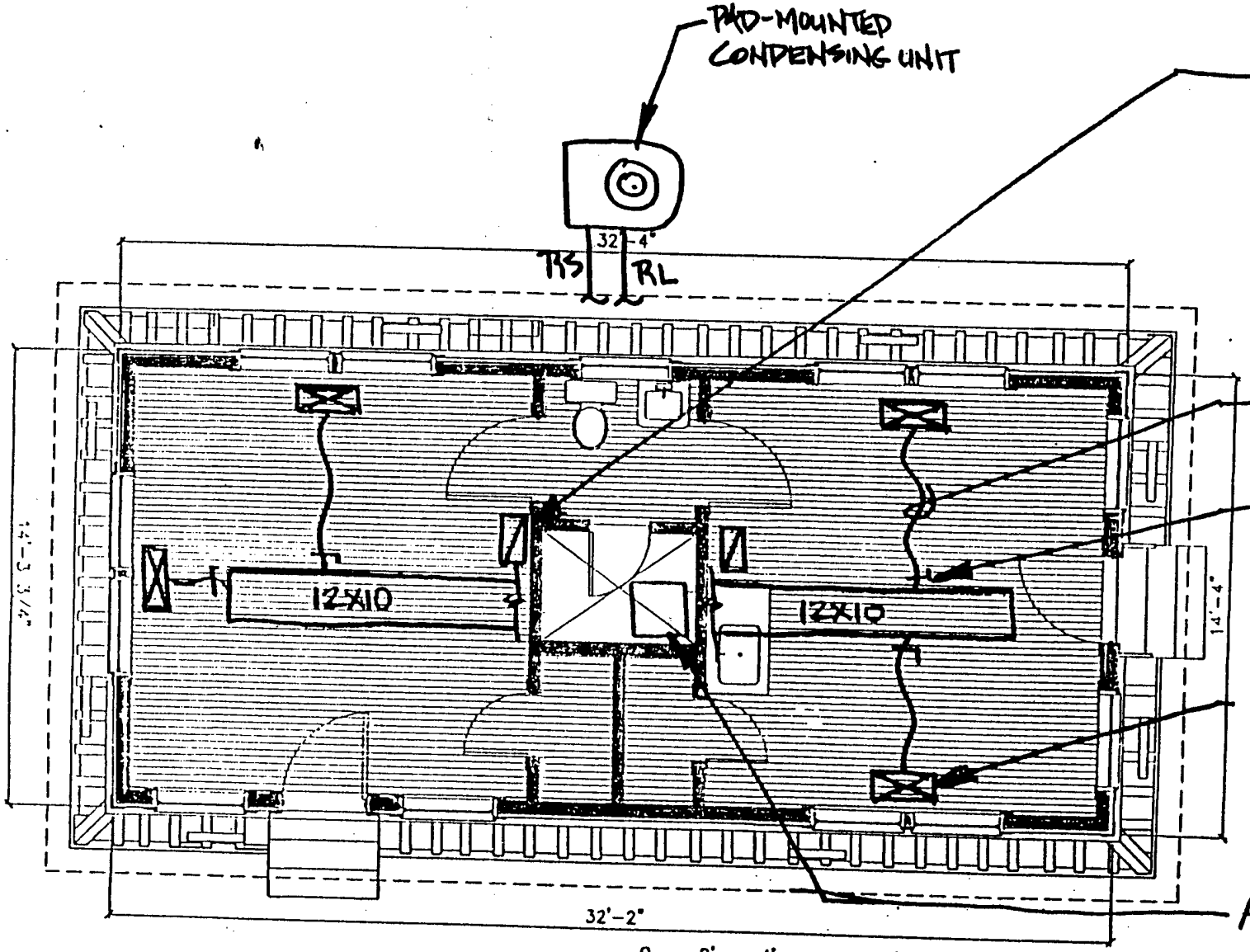
ELEVATION – NORTHWEST ELEVATION

BUILDING #149 (SIM. BLDG. 151)

0 2' 4' 8' 12'
GRAPHIC SCALE: 1/4" = 1'-0"

0 50 100 300
GRAPHIC SCALE: CENTIMETERS 1:48

A6



16X8 RETURN GRILLE MOUNTED IN FLOOR, DUCTED VIA 12X10 DUCT BACK TO AIR HANDLER (TYP 2)

8" ⌀ INSULATED FLEX DUCT (TYP. 4)

LOCKING VOLUME DAMPER (TYP. 4)

12X6 SUPPLY REGISTER MOUNTED IN FLOOR (100 CFM - TYP. 4)

AIR HANDLER

FLOOR PLAN
BUILDING

0 2' 4' 8' 12'
GRAPHIC SCALE: 1/4" = 1'-0"

0 50 100 300
GRAPHIC SCALE: CENTIMETERS 1:48

MECHANICAL PLAN

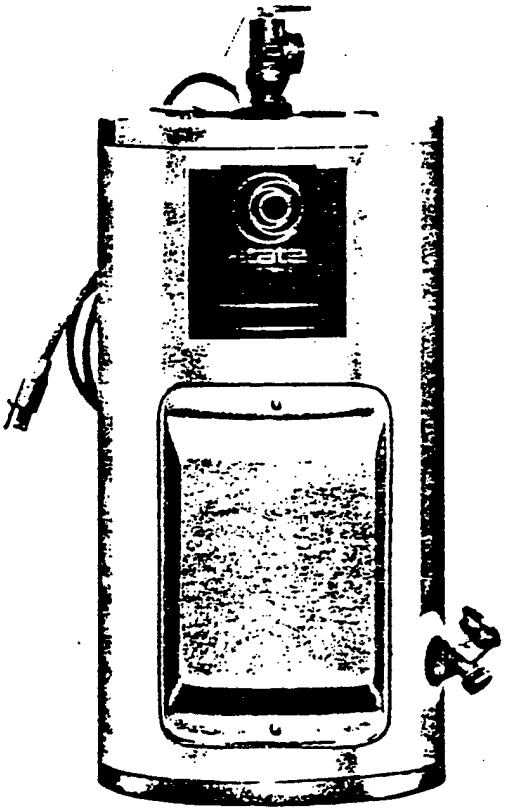
M1 (7)
/F7

state

POINT-OF-USE

FOR LOW-DEMAND "POINT-OF-USE" APPLICATIONS
SANDHOG HEATING ELEMENT WITH LIFETIME WARRANTY
110/120 VOLT CORD SET ELIMINATES SPECIAL WIRING
WALL BRACKETS FOR INSTALLATION FLEXIBILITY

The point-of-use electric water heater is ideal for small lavatories in gas stations, offices, homes, anywhere where hot water demand is limited. Its compact size (2-gallon model stands only 12¾" high) means it can be easily installed in vanity cabinets and other small spaces.



Energy-Efficient. Insulation surrounds the tank for maximum heat retention. Meets minimum state efficiency requirements. Also meets ASHRAE Standard 90A-1980 and B.O.C.A. Code.

110/120 Volt Cord Set. Standard 3-pronged plug on all 120 volt models. No special wiring, no special outlets, just plug it in!

Wall Mounting Brackets. Included with each water heater, permits fast, easy wall mounting if necessary.

Sandhog Heating Element. With lifetime limited warranty. Special construction makes it virtually indestructible. Standard on models SCI-2-1SUS4-K, SCI-4-1SUS4-K and SCI-2-1SUS4-E only.

Glasslined Tank. Protects against rust and corrosion.

Automatic Thermostat. Provides hot water at a pre-selected temperature.

Maximum Hydrostatic Working Pressure: 150 PSI.

Factory Installed Temperature and Pressure (T&P) Relief Valve.

All models listed feature a 1-year tank warranty, 90-day parts warranty and comply with safety specifications outlined in Underwriters' Laboratories, Inc. Standards for Safety (U.L. 174).

POINT-OF-USE

SPECIFICATIONS

Model Number	Gal. Cap.	Standard Element Wattage	Recovery–GPH Degree Rise 100°	90°	60°	Minimum Wire Size*	Maximum Fuse or Circuit Breaker (Amps)	Dimensions in inches Height	Diameter	Approx. Ship Wt. (Lbs.)
120 VOLT MODELS										
SCI-2-1SUS4-K	2	1440	6	7	10	12 AWG	20	12¾	10	21
SCI-4-1SUS4-K	4	1440	6	7	10	12 AWG	20	20	10	27
240 VOLT MODELS										
SCI-2-1SUS4-E	2	1500	6	7	10	12 AWG	20	12¾	10	21
SCI-4-1SUS4-E	4	3800	16	17	26	12 AWG	20	20	10	27

*Minimum Wire Size based on 60 C Copper Conductor.
Recoveries are rounded to nearest gallon.
All models have ½" NPT inlet and outlet connections.
All models have ¾" NPT T&P Valve opening.

AVAILABLE ELEMENT WATTAGES FOR THE POINT-OF-USE WATER HEATERS:

	120 VOLT	120 Volt Part Number	240 VOLT/208 VOLT	240 Volt Part Number	Wattage Available 2 Gal.	4 Gal.
1.	600 LWD	9000341	600 LWD	9000343	YES	YES
2.	750 LWD	9000342	750 LWD/600 LWD	9000201	YES	YES
3.	1000 LWD	9000140	1000 LWD/750 LWD	9000131	YES	YES
4.	1250 LWD	9000470	1250 LWD/1000 LWD	9000200	YES	YES
5.	*1440 SH	9001511	–	–	YES	YES
6.	1500 HWD	9000129	1500 HWD	9000132	YES	YES
7.	–	–	*1500 SH	9001520	YES	YES
8.	1650 HWD	9000253	–	–	YES	YES
9.	–	–	1750 MWD/1250 MWD	9001475	YES	YES
10.	–	–	2000 HWD/1500 HWD	9000133	NO	YES
11.	–	–	3000 HWD	9001476	NO	YES
12.	–	–	3800 HWD/3000 HWD	9001477	NO	YES

NOTE: Asterisk (*) identifies Sandhog/Lifelong elements.
The 1440 watt Sandhog/Lifelong element #0740695-00 will be considered standard for the 120 volt 2 and 4 gallon models.
The 1500 watt Sandhog/Lifelong element #0740693-00 will be considered standard for the 240 volt 2 gallon model.
The 3800 high watt element #0740690-00 will be considered standard for the 240 volt 4 gallon model.

Complete warranty details available at nearest State sales office. Specifications are subject to change without prior notice.

state INDUSTRIES, INC.
500 By Pass Road Ashland City, TN 37015-1299

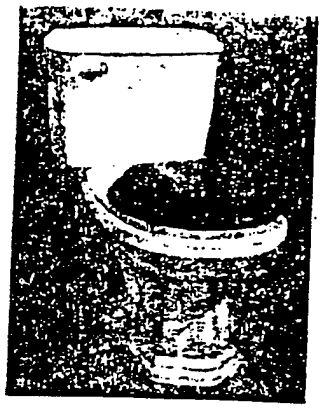
POU 24/494
Printed in U.S.A.

Designer Series

CONTEMPO 1.5
Model #4009
Shown in Cappuccino
- Soft, contemporary, one-piece design with elongated rim bowl
- Flushes on 1.5 gallons—gravity flush
- Tapered tank with form-fitting lid
- Deluxe elongated seat included
- Custom designed metal flush lever

BORDEAU 1.5
Model #4006
Shown in Cranberry
- Elegantly styled, low-profile, one-piece design with regular rim bowl
- Flushes on 1.5 gallons—gravity flush
- Stylish side mounted flush button
- Also available with elongated rim bowl model #4005

SATURN® 1.5
Model #4023
Shown in Blue Mist
- Stylish low-profile, one-piece design with regular rim bowl
- Flushes on 1.5 gallons—gravity flush
- High style push button flush
- Also available with elongated rim bowl model #4022

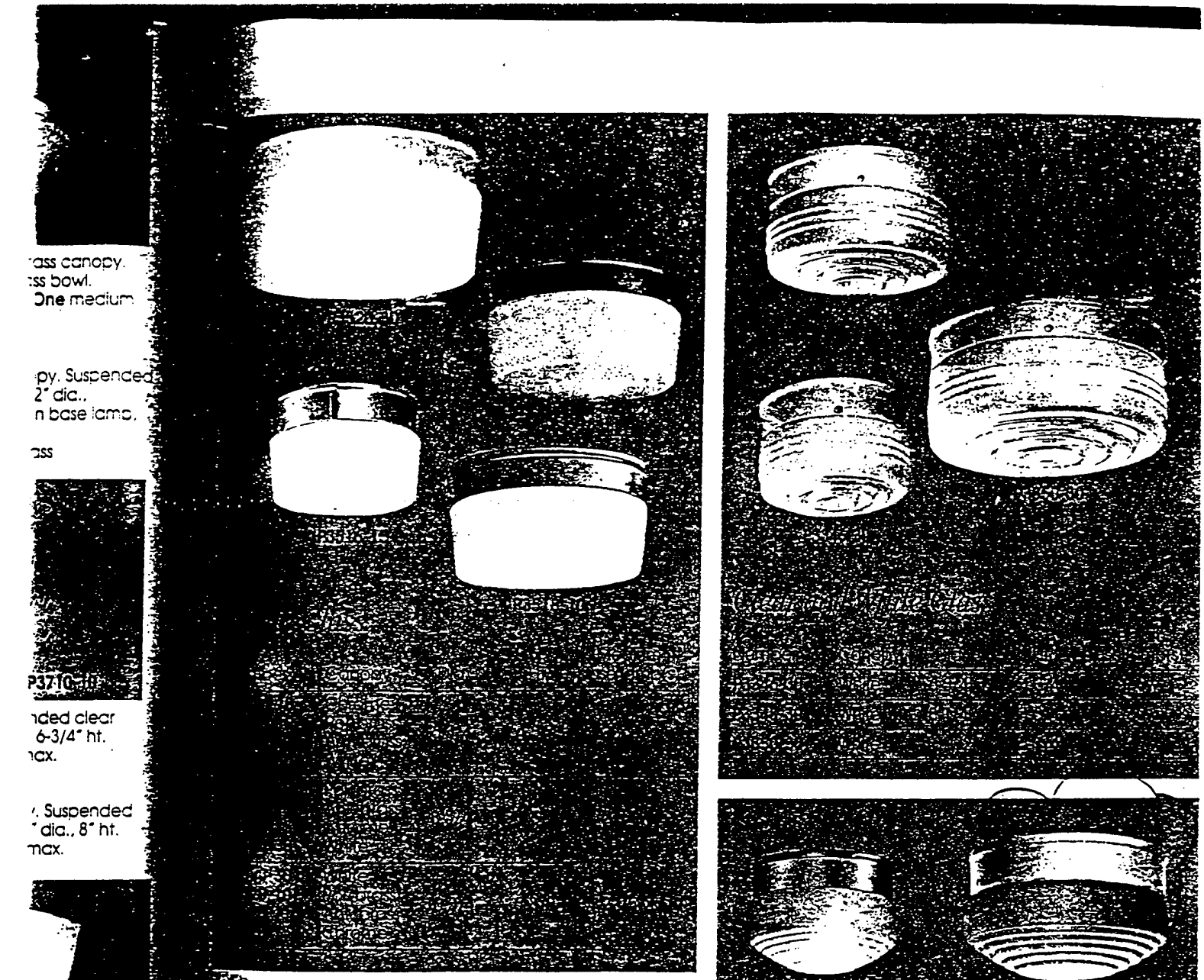


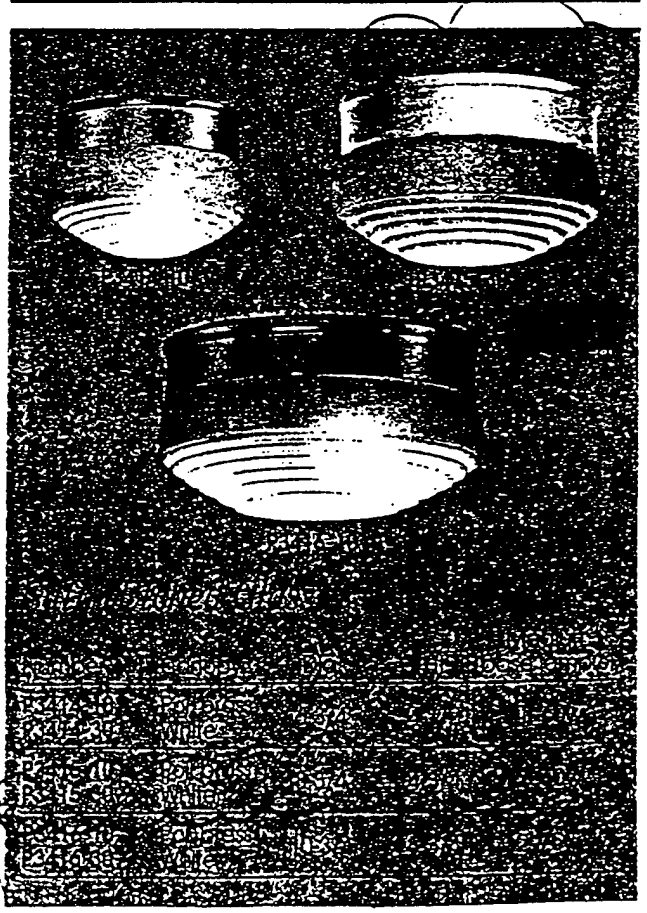
VINTAGE LACE 1.5
Model #4060
Shown in White
- Graceful turn-of-the-century styling with regular rim bowl
- Uniquely decorated with a fired-on motif of traditional lace design
- Flushes on 1.5 gallons—gravity flush
- Traditional chrome finish brass tank lever

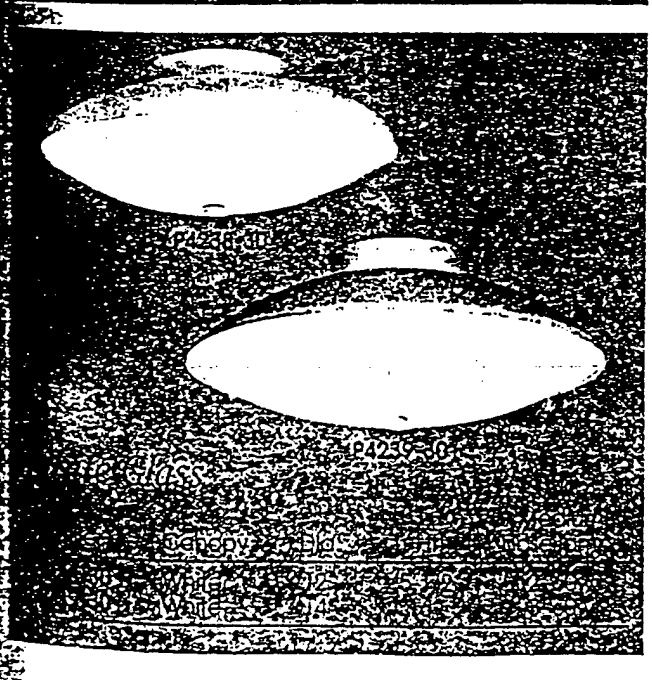
WINDFLOWER 1.5
Model #4024
Shown in White
- Sleek, contemporary two-piece design with elongated rim bowl
- Flushes on 1.5 gallons—gravity flush
- Graceful floral decaled tank with side mounted push button flush

NOSTALGIA 1.5
Model #4065
Shown in White
- Classic turn-of-the-century design with regular rim bowl
- Flushes on 1.5 gallons—gravity flush
- Stylish raised rim on the tank lid and traditional chrome finish brass tank lever

needs white x-ref







'ass canopy.
ss bowl.
One medium

py. Suspended
2" dia..
n base lamp.

ass

P3710-

ded clear
6-3/4" ht.
ax.

. Suspended
" dia., 8" ht.
nax.

Newport

P5066-30 White cord-hung pendant. Pagoda-style shades are white innerlined for greater reflectivity. White ribbed glass diffuser. 10" dia., 8-3/4" ht. Overall ht. to 48". **One** medium base lamp. 100w max.
P5066-31 Black

P5067-30 Compact fluorescent. White. Same as P5066-30 except stem-mounted. Standard 120V NPF ballasts. Lamps: **Two** PL-7.
P5067-31 Black

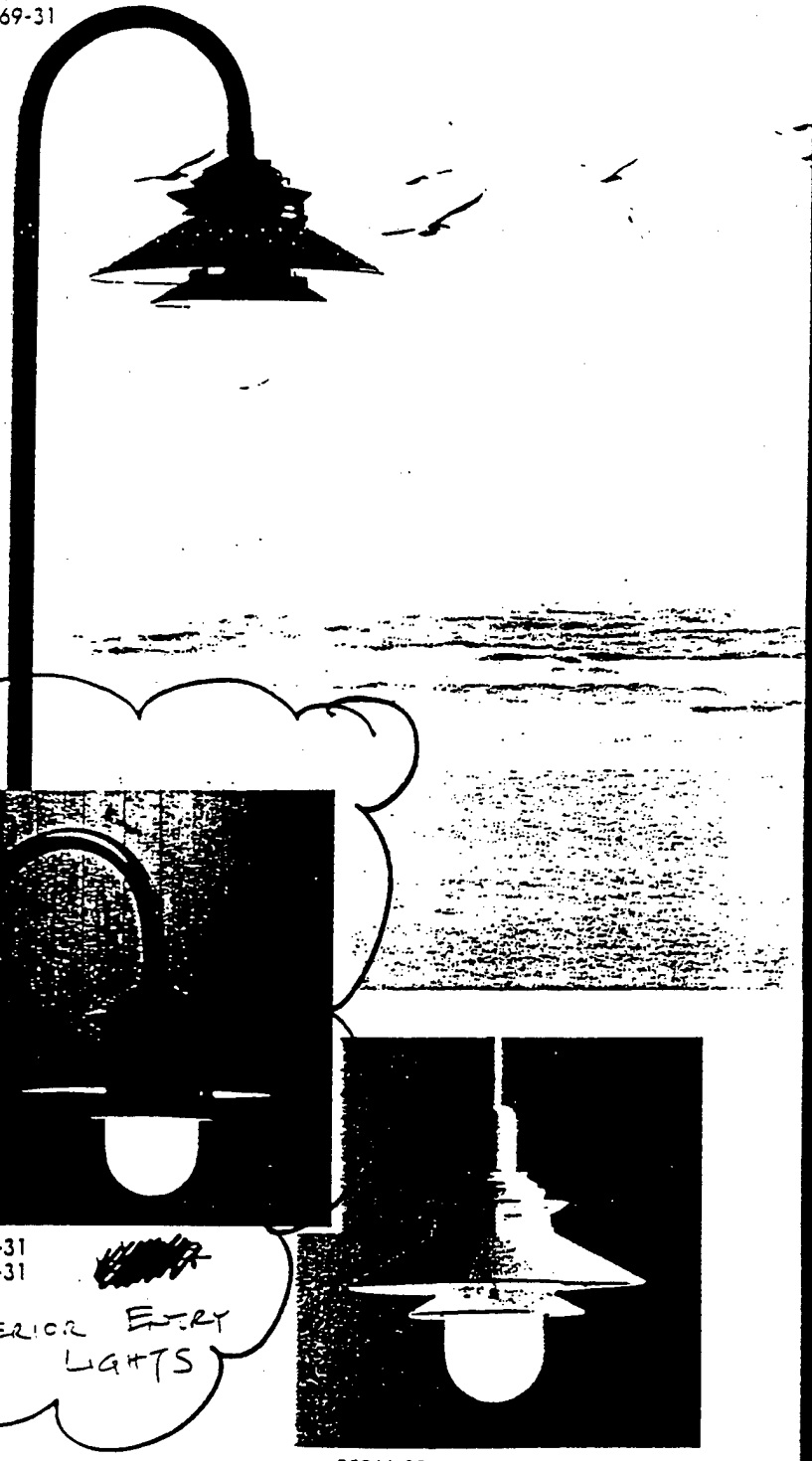
P5268-31 Black path light. Pagoda-style shades are white innerlined for greater reflectivity. Ribbed white glass diffuser 10" dia. Overall height to 37". 1/2" NPS thread. Requires weatherproof junction box (by others). For direct burial only. **One** medium base lamp, 100w max.
P5268-30 White

P5269-31 Compact fluorescent. Black. Same as P5268-31 except for direct burial or surface mount. Complete with weatherproof ballasted junction box. Standard 120V NPF ballasts. Lamps: **Two** PL-7.
P5269-30 White

P5666-31 Black. Pagoda-style shades on arched wall bracket. White ribbed glass diffuser. 10" W., 11-3/4" ht. Extends 11". **One** medium base lamp, 100w max.
P5666-30 White

P5667-31 Compact fluorescent. Black. Same as P5666-31 except with standard 120V NPF ballasts. Lamps: **Two** PL-7.
P5667-30 White

P5268-31
P5269-31



P5666-31
P5667-31

EXTERIOR ENTRY LIGHTS

P5066-30
P5067-30

Energy Efficient Fluorescent

Appendix B - Nutec Materials Safety Data Sheet

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY (As Used on Label and List) NUTEC Semi
aste paint and varnish Stripper

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that

Section I

Manufacturer's Name UTEC Industrial Chemical Co., Inc.	Emergency Telephone Number 800-535-5053
Address (Number, Street, City, State, and ZIP Code) 0404 69th Ave. NE	Telephone Number for Information 800-523-4114
rlington, WA 98223-3306	Date Prepared 1-11-95
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))		OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Acetone	67-64-1	750 ppm	1800 mg/m^3	1000 ppm/2400 mg/m^3	
Caution: Prolonged or repeated topical use may cause eurhythmia, dryness. Inhalation may produce narcosis.					
Methanol	67-56-1	200 ppm	260 mg/m^3	250 ppm/310 mg/m^3	
Caution: Poisoning may occur from ingestion, inhalation or percutaneous absorption.					
Methyl Ethyl Ketone	78-93-3	200 ppm	590 mg/m^3	300 ppm/885 mg/m^3	
Toluene	108-88-3	100ppm	375	150 ppm/560	
Caution: Narcotic in high concentrations.					

Section III — Physical/Chemical Characteristics

Boiling Point 132 (°F)		Specific Gravity (H_2O = 1) 0.814 (g/ml)	
Vapor Pressure (mm Hg.) 147 (mm Hg)		Melting Point N/A	
Vapor Density (AIR = 1) 2.5		Evaporation Rate (Butyl Acetate = 1) 8.5	

Solubility in Water
75%

Appearance and Odor
Clear liquid, Sweet odor

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used) 86 °F open cup	Flammable Limits in air % by volume	LEL 1.5	UEL 12.0

Extinguishing Media
Water fog, CO2, Dry Chemical on small fires. Foam for large fires.

Special Fire Fighting Procedures
Wear self contained breathing appartus, protective clothing. Cool fire exposed containers with water spray to prevent pressure buildup.

Unusual Fire and Explosion Hazards
Flammable liquid; can be ignited by sparks or flame, electrical equipment static discharges etc., vapor and air can form explosive mixtures-

(Reproduce locally) see LEL/UEL range above.

Section V -- Reactivity Data

Stability	Conditions		Conditions to Avoid
	Unstable		Avoid high temperatures, open flames, sparks, othe
	Stable		potential ignition sources.

Incompatibility (Materials to Avoid)
Avoid contact with strong oxidizers, alkalis, acids, bases

Hazardous Decomposition or Byproducts Carbon oxides, traces of formaldehyde vapors, unidentifiable organic materials.

Hazardous Polymerization			Conditions to Avoid
	May Occur		N/A
	Will Not Occur	X	

Section VI -- Health Hazard Data

Route(s) of Entry Inhalation? Skin? Ingestion?

Health Hazards (Acute and Chronic)
Should avoid exposure above O.S.H.A. PEL's by providing adequate air movement or proper breathing apparatus. Avoid contact with eyes, wash immediately, see physician. If ingested induce vomiting, see physician.

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure
When over exposed slight reddening of eyes and dizziness may occur.

Medical Conditions Generally Aggravated by Exposure
None

Emergency and First Aid Procedures
Wash eyes or skin with water if exposed directly. Induce vomiting if ingested, see physician for eyes or ingestion.

Section VII -- Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Immediately extinguish ignition sources, ventilate area. Take up gross quantities with non-sparking tools, place into an approved disposal drum. Take up residue on an inert, non-flammable absorbent material and place

Waste Disposal Method
into an approved waste container for disposal. Comply with all Federal, State and Local regulations regarding disposal of hazardous wastes.

Precautions to Be Taken in Handling and Storing
Store away from high temperatures, open flame, other potential ignition sources, out of direct sunlight, away from incompatibles. Store at

Other Precautions
temperatures under 120 F. Avoid skin contact, wear neoprene gloves. Avoid eye contact, ingestion, breathing of vapors. Use with adequate

Section VIII -- Control Measures

ventilati

Respiratory Protection (Specify Type)
Wear a NIOSH approved cartridge-type respirator specific for organic vapor

Ventilation		
	Local Exhaust At points where vapors escape to workplace air	Special Explosion-proof equipment is recommended
	Mechanical (General) maintain airborne levels below TLV's	Other None

Protective Gloves	Eye Protection
Neoprene	Chemical safety goggles

Other Protective Clothing or Equipment Wear an impervious apron or other protective clothing to prevent skin contactduring use. Eye bath safety shower should be located near point of use.

Work/Hygienic Practices
Wash thoroughly with soap and water after use, before eating, drinking, or smoking, with soap and water.

No eating, drinking, or smoking at point of use.

Nutec Industrial Chemical Inc.
Material Safety Data Sheet

Identity: Nutec liquid paint and varnish Stripper

NFPA Haz Rating

Health	2	4 = Extreme
Fire	3	3 = High
Reactivity	0	2 = Moderate
Special		1 = Slight
		0 = Insignificant

See section V

Section I

Manufacturers name
Nutec Industrial Chemical Inc.
Address
20404 69th Ave. N.E.
Arlington, Wa. 98223-3306

Emergency telephone number
(800) 535-5053
Telephone number for information
(800) 523-4114
Date Prepared: January 18, 1994
Date Revised: September 5, 1994
Prepared by
Vincent M. Brotherton Sr Chemist
Signature

Section II

Hazardous Ingredients identity and exposure information

Hazardous Component	CAS#	TWA OSHA PEL	TWA ACGIH TLV	Other Limits (STEL) Recommended
Acetone	67-64-1	750 ppm	1800 mg/m^3	1000 ppm/2400 mg/m^3
Caution: Prolonged or repeated topical use may cause eurhythmia, dryness. Inhalation may produce narcosis				
Methanol	67-56-1	200 ppm	260 mg/m^3	250 ppm/310 mg/m^3
Caution: Poisoning may occur from ingestion, inhalation or percutaneous absorption.				
Methyl Ethyl Ketone	78-93-3	200 ppm	590 mg/m^3	300 ppm/ 885 mg/m^3.
Toluene	108-88-3	100 ppm	375	150 ppm/ 560
Caution: Narcotic in high concentrations.				

Section III

Physical and Chemical Characteristics

Boiling Point (°F)	Specific Gravity (g/ml)	Vapor Pressure (mm Hg)
132	0.814	147
Melting point	**Vapor Density (Air = 1)**	**Evaporation Rate (Butyl Acetate = 1)**
N/A	2.5	8.5
Solubility in Water	**Appearance and Odor**	
75%	Clear Liquid, Sweet odor	

Section IV

Fire and Explosion Hazard Data

Flash point (closed cup)	Ignition point	Flammable limits in air % by volume	
< 80°F	464 °F	LEL 1.5	UEL 12.0

Extinguishing Media

Water fog, CO2, Dry Chemical on small fires. Foam for large fires.

Special Fire Fighting Procedures

Wear self contained breathing apparatus, protective clothing. Cool fire exposed containers with water spray to prevent pressure buildup.

Unusual Fire and Explosive Hazards

Flammable liquid: can be ignited by sparks or flame, electrical equipment static discharges etc., vapor and air can form explosive mixtures - see LEL/ UEL range above.

Section V

Reactivity Data

Stability	Conditions To Avoid
Stable	Avoid high temperatures, open flames, sparks, other potential ignition
Hazardous Polymerization	sources.
Will not occur	Material Incompatibilities
Conditions to Avoid	Avoid contact with strong oxidizers, alkalis, acids, bases
n/a	Hazardous Decomposition or by products
	Carbon oxides, traces of formaldehyde vapors, unidentifiable organic materials

Section VI

Health Hazard Data

Should avoid exposure above O.S.H.A. PEL's by providing adequate air movement or proper breathing aparatus. Avoid contact with eyes, wash immediately, see physician.
If ingested induce vomiting, see physician.

Section VII

Precautions for Safe Handling and Use

Steps to be taken in case material is released or spilled

Immediately extinguish ignition sources, ventilate area. Take up gross quantities with non-sparking tools, place into an approved disposal drum. Take up residue on an inert, non-flammable absorbent material and place into an approved waste container for disposal.

Waste disposal method

Comply with all Federal, State and Local regulations regarding disposal of hazardous wastes. Consult local authorities for proper disposal procedures.

Precautions to be taken in handling and storing

Store away from high temperatures, open flame, other potential ignition sources, out of direct sunlight, away from incompatibles. Store at temperatures under 120°F.

Other Precautions

Avoid skin contact, wear neoprene gloves. Avoid eye contact, ingestion, breathing of vapors. Use with adequate ventilation.

Section VIII

Control Measures

Respiratory protection

Wear a NIOSH approved cartridge-type respirator specific for organic vapors. If TLV's are exceeded Air supplied respirators or Self Contained Breathing Apparatus should be worn. Note: do not exceed manufacturer's prescribed limitations for respirator type.

Ventilation	Local Exhaust
	At points where vapors escape to workplace air
	Mechanical (General)
	maintain airborne levels below TLV's
	Special
	Explosion-proof equipment is recommended
	Other
	None
Protective Gloves	Eye Protection
Neoprene	Chemical safety goggles

Other protective clothing or Equipment

Wear an impervious apron or other protective clothing to prevent skin contact during use. Eye bath and safety shower should be located near point of use.

Work/Hygienic Practices

Wash thoroughly with soap and water after use, before eating, drinking, or smoking, with soap and water. No eating, drinking, or smoking at point of use.

V.O.C. 807 g/L

Provided data is offered in good faith as typical values and not as a product specification. No warranty, either express or implied, is hereby made. The recommended industrial hygiene and safe handling procedures are believed to be generally applicable, however, each user should review these recommendations.

Appendix C - Hazard Communication Program

POWER ENVIRONMENTAL ABATEMENT TECHNOLOGIES, INC.

HAZARD COMMUNICATION PROGRAM

Power Environmental Abatement Technologies, Inc.
3556 Lakeshore Rd.
Suite # 740
Buffalo, NY 14219
Phone: (716) 823-9792
Fax: (716) 823-9456

I. GENERAL POLICY AND PURPOSE:

The purpose of this program is to inform all employees of Power Environmental Abatement Technologies, Inc. (PEAT) of potential hazards in the workplace and of PEAT's efforts and methods in complying with OSHA Communication Standard, Title 29 of the Code of Federal Regulations Part 1910.1200 or for the Construction Industry Part 1926.59

Mr. James C. Lyskawa is the designated Program coordinator and has overall responsibility for the program.

II. LIST OF HAZARDOUS CHEMICALS AND SUBSTANCES:

PEAT in its operations will expose its employees to the following hazardous substances and chemicals: lead paint chips, lead paint dust, paints, stains, environmentally compatible paint strippers and cleaning agents.

PEAT is in the painting industry with its emphasis on its paint removal operations. This program will emphasis PEAT's paint removal procedures. When PEAT will do painting/staining work, PEAT will inform the employee of any chemical hazard.

PEAT will keep a list of all hazardous substances and chemicals, and relating Material Safety Data Sheets (MSDS) in a red box on all of its service trucks and at Mr. Lyskawa's corporate office at 3556 Lakeshore Rd., Suite # 740, Buffalo, NY 14219.

When using chemical strippers, PEAT will make available the list of all hazardous chemical associated with the chemical strippers available through the MSDS sheets. Once again, the employee is reminded that the greater danger is in the lead paint which is being removed.

III. MATERIAL SAFETY DATA SHEETS:

Mr. Lyskawa will obtain MSDS for each hazardous chemical in the work place. They can be found in the red box on all PEAT's service trucks and at Mr. Lyskawa's corporate office at 3556 Lakeshore Rd.,Suite # 740, Buffalo, NY 14219.

Mr Stephen Sosnowski, crew foreman, will be responsible for the red box on the truck.

IV. EMPLOYEE TRAINING AND INFORMATION:

Employees will be warned that they will be working in a lead work area. Exhibit #1 highlights these dangers.

Employees will be informed that Lead can cause damage to their Blood, Kidneys, Nervous System, and Male and Female Reproductive Systems.

Employees will learn the early symptoms of lead poisoning which are: unusual feeling of tiredness, irritability & depression, trouble sleeping and concentrating, stomach cramps, constipation, weakness in arms and legs.

Employees will be trained in methods to reduce lead exposure including respirator protection, protective clothing, health tests (physical exam, and blood lead tests), washing before eating or smoking, and other engineered controls.

Employees will be trained in how to read MSDS and where they are located.

Employees will given a copy of 29 CFR Part 1926.59 OSHA Hazard Communication Standard and 29 CFR Part 1926.62 Lead Exposure in Construction: Interim Final Rule.

Respiratory Protection:

Sanders will wear a Full-faced respirator. All other workers will wear a half-face or full-face respirator. All respirator will be equipped with a High Efficiency Particulate Filter (HEPA). When chemical strippers are used, an organic vapor cartridge with HEPA filter will be used.

Each employee will be examined physically for pulmonary distress and general health. Employee will choose a full-face and half-face respirator that fits his face size. The respirator will be fit-tested by qualitative and quantitative methods.

For further information see Respirator Protection Program.

Protective Clothing and Equipment:

Each employee will be given rubber gloves and boots, hats, goggles, Tyvek suits and hoods and other clothing to protect themselves. Each employee will be instructed as to proper fit, cleaning procedures, and disposal of protective clothing and equipment.

Health Tests:

Each employee will be on medical surveillance to measure blood lead levels. Blood monitoring will adhere to guidelines in 29 CFR 1926.62.

Each employee will be given a physical exam for general health and pulmonary functions.

Housekeeping:

Wash areas will be set up for employees to wash after working in a lead workplace. All employees will have to wash before eating, drinking and smoking. An area free of lead will be established for lunch and break times. When chemical strippers are used, an eye wash station will be available to the employees.

WARNING

Lead Work Area

POISON

No Smoking, Eating or Drinking

LEAD CAN DAMAGE THE BLOOD, KIDNEYS, NERVOUS SYSTEM, AND MALE AND FEMALE REPRODUCTIVE SYSTEMS

Early Symptoms of Lead Poisoning

Unusual feeling of tiredness, irritability & depression, trouble sleeping and concentrating, stomach cramps, constipation, weakness, in arms and legs.

Prevent Lead Exposure With These Methods:

- Local exhaust ventilation - most important
- Respirators - clean, properly selected, fit tested
- Good housekeeping - use wet methods or high-efficiency vacuum
- Lunch and break areas - free of lead, wash before eating
- Health tests - physical exam, blood lead tests
- Keep lead away from your home and family - shower, wear clean clothes home

---

For more information on lead hazards and controls:

Contact your employer or the
New York State Department of Health
Bureau of Occupational Health
at
800-458-1158 or 518-458-6228

(Please photocopy as needed)

6/92

Appendix D - Lead-based paint Removal/Abatement Plan

Power Environmental Abatement Technologies

Lead Paint Removal/Abatement Plan

Kelly Air Force Base, Texas

1. INTRODUCTION

This plan describes how Power Environmental Abatement Technologies (PEAT) will remove lead based paint from Kelly AFB Building # 151. The plan will utilized a laser based lead paint removal procedure, followed with a chemical paint remover for all areas in which the laser technique is not viable.

2. STARTING DATE: No date has been established.

As of January 30, 1995, the laser equipment is not ready to be put into service. It is estimated that this problem will be corrected by April 1, 1995.

3. COMPLETION DATES: To be determined.

4. EXECUTION OF LEAD PAINT REMOVAL/ABATEMENT

PEAT will perform the following tasks to complete Kelly AFB purchase order:

A. Interior environmental and building protection.
B. Exterior environmental and building protection.
C. Paint removal from building.
D. Clean-up the work area.

Due to the two removal methods, laser and chemical stripping, PEAT will use two distinct operations for each removal method.

CHEMICAL STRIPPING:

A. INTERIOR ENVIRONMENTAL AND BUILDING PROTECTION

PEAT will construct an interior containment to limit access to the lead abatement area. Warning signs will be posted at all entrances to the building with the following legend: "Danger --LEAD Abatement Hazard, Authorized personnel Only" and/or "Danger; Lead Abatement Area; Authorized Personnel Only; Respirators and Protective clothing are required in this area."

All interior rooms, PEAT will use 6 (six) mil flame retardant polyethylene (poly) tarps to cover all floors, carpeting, furniture, and any other cloth surfaces. All floor surfaces will be covered with two(2) layers of poly. Entrance to containment will be through a distinct two (2) part vestibule with 3-layer tarp overlay. PEAT will supply all materials to protect the inside of the building.

All Heating/Air conditioning systems will be turned off while abatement work is being performed. After each daily cleaning of paint abatement residue, the heating/cooling system will be turned on as needed.

PEAT will use three (3) air filtration units inside containment to reduce the possibility of visible emissions escaping the containment. Each unit can exhaust 2,500 CFM (cubic feet per minute). The filtered air will be remove from the containment through exhaust ports in the containment tarps. The filtered air will pass through three filters before exiting. The air first passes through a primary filter, then a secondary filter and then finally through a HEPA filter.

B. EXTERIOR ENVIRONMENTAL AND BUILDING PROTECTION

When performing exterior abatement procedures, PEAT will attach poly tarps to the building and will lay down poly tarps 15 (fifteen) feet from the surface area to be abated. A containment wall will be constructed to limit the exposure of lead paint chips to the surrounding area when weather conditions or air monitoring results require containment. All ground tarps will consist of two (2) layers of six mil poly.

PEAT will collect and place all paint chips created by the stripping process into approved 55 galloon drums for disposal.

The containment will consist of a ground tarp, a roof tarp and possible side tarps. Each tarp will be attached to the building and each other to prevent any lead particles or visible emissions from escaping the containment.

The containment structure will be built with ladders, poles, tarps, and clamps. The containment will be sealed or attached with staples, glue, clamps, and tarp overlays. Entrance to containment will be through a distinct two (2) part vestibule with 3-layer tarp overlay. PEAT will supply all equipment and materials to construct containment.

PEAT will restrict access to the work area by installing temporary fencing around the building and by posting warning signs of potential lead hazards.

PEAT will use three (3) air filtration units inside containment to reduce the possibility of visible emissions escaping the containment. Each unit can exhaust 2,500 CFM (cubic feet per minute). The filtered air will be remove from the containment through exhaust ports in the containment tarps. The filtered air will pass through three filters before exiting. The air first passes through a primary filter, then a secondary filter and

then finally through a HEPA filter.

The site will be surveyed for storm drain inlets which might receive run off from the abatement area. Storm run-off control measures (eg. silt fence, hay bails, and/or inlet covers) will be installed at the abatement site to prevent lead paint chips or dust from entering the storm drain system.

C. PAINT REMOVAL FROM BUILDING

PEAT will remove the lead based paint from the wood substrate by heat gun, hand tools, and/or environmentally compatible chemical paint strippers. PEAT will provide all equipment necessary to perform paint removal operations.

PEAT will provide the Kelly AFB EMP POC with MSDS of chemical paint strippers to be used. PEAT will coordinate and consult with Kelly AFB Environmental Management Hazardous Material Team. All appropriate MSDS sheets will be stored on-site. PEAT applies chemical paint strippers by spray gun or by brush. The chemicals are removed with hand tools (scrapers, wire brush, etc).

When using heat guns, PEAT will consult with Kelly AFB Fire Department to comply with all local fire codes. PEAT's heat gun procedures include, but are not limited to, fire extinguisher in all rooms where heat gun is in use, wet towel wipe down on all surfaces stripped by heat gun, and visual inspection ½ hour after heat gun procedures are completed each day.

PEAT will perform all paint removal operations with workers who have been properly trained with the equipment being utilized. All workers will be protected according to OSHA requirements for lead (See Worker Protection Plan).

D. CLEAN-UP

PEAT will clean-up the lead paint abatement work area daily. All lead paint residue and waste will be poured, vacuumed, or shoveled into drums and labeled. All lead contaminated waste will be collected and put into separate containers or drums for disposal. All lead contaminated equipment will be cleaned with a vacuum cleaner containing a HEPA filter, hereafter HEPA-VAC, or washed with Ledisolv or like solution. The interior containment structure will be dismantled after final clearance testing and approval. Exterior containment will be dismantled daily unless it is necessary to protect the environment overnight.

After all interior poly has been removed, the interior clean-up shall consist of a thorough HEPA-VAC and washing with a Ledisolv or like solution. Lead dissolve solution is disposed though o five (5) micron water filter or as household waste.

PEAT will provide all cleaning supplies and waste containers.

LASER STRIPPING:

A. INTERIOR ENVIRONMENTAL AND BUILDING PROTECTION

The laser Stripping process is designed to catch and filter all lead paint particulate created by the stripping process. Therefore, no interior containment or building protection is needed.

To test the manufacturers above claim, PEAT will initially lay down poly tarps and conduct wipe sampling tests to determined if lead dust is produced. If no lead dust is produced, PEAT will proceed as described. If lead dust is produced, PEAT will lay down poly tarps and build containment structures as determined by the dust levels.

The laser stripping will only be used on substrates where it is completely save, mainly flat surfaces. The system is designed to not "shoot" the laser beam unless all safety controls are meet. The laser beam will not "shoot" unless its protective shroud is attached to the substrate completely.

B. EXTERIOR ENVIRONMENTAL AND BUILDING PROTECTION

The laser Stripping process is designed to catch and filter all lead paint particulate created by the stripping process. Therefore, no exterior containment or building protection is needed.

To test the manufacturers above claim, PEAT will initially lay down poly tarps and conduct wipe sampling tests to determined if lead dust is produced. If no lead dust is produced, PEAT will proceed as described. If lead dust is produced, PEAT will lay down poly tarps and build containment structures as determined by the dust levels.

C. PAINT REMOVAL FROM BUILDING

The laser system is a pulse laser which is designed to pulse only after reading the surface to be stripped. This feedback system guarantees that the laser only pulses under the criteria established by the operator. The main safety criteria is that the laser beam pulse will not "shoot" unless its protective shroud is correctly attached to the substrate. The laser machine will be operated by personnel who have been trained in its operation.

D. CLEAN UP

Due to the self containment of the laser paint removal system, Very little clean up will be necessary. If needed, PEAT will clean up using the guidelines of chemical stripping.

5. EQUIPMENT

PEAT anticipates using the following equipment:

Air filtration units Fire extinguisher
Ladders Heat guns
Hand tools Laser Stripping Machine
HEPA-Vac

Appendix E - Respirator Protection Program

Power Environmental Abatement Technologies

Respiratory Protection Program

Kelly Air Force Base, Texas

I. James C. Lyskawa, President of Power Environmental Abatement Technologies (PEAT), is the administrator of this program.

II. SELECTION OF RESPIRATORS:

The following responsibilities will require these respirators:

Sander: Full-face respirator.
Clean-up: Half-face respirator.
Chemical Strippers: Full-face or Half-face respirator as needed.
Laser Stripping: No respirator needed.

All respirators will use a High Efficiency Particulate Filter(HEPA) cartridge. When Chemical paint strippers are used, an organic vapor/HEPA cartridge will be used.

Each Employee will go to either of the following suppliers to select a respirator that will fit their face size.

Dival Safety EquipmentWatson Sales Co
1721 Niagara St.990 Kenmore Ave.
Buffalo, NY 14207Buffalo, NY 14216
716 874-9060716 877-1164

III. INSTRUCTION AND TRAINING:

Donning and Fit check procedures are illustrated in exhibit #1. These procedures **must** be done daily. Each employee will be trained by the administrator or by an outside source before beginning work in a lead paint operation.

A. Interior Chemical/Hand Tool Removal

PEAT employees will be exposed to small amount of lead paint dust created with and tool removal procedures. Chemical stripping does not produce significant level of lead dust but may produce strong odors which may be an irritant to the workers. Therefore, PEAT will supply organic vapor cartridges with a HEPA filter to alleviate this potential problem.

Each employee will medically cleared to wear their respirator at:

Union Occupational Health Center
450 Grider St.
Buffalo, NY 14215
716 894-9366

Each employee will receive a qualitative fit test using Irritant Smoke to insure that their respirators fit correctly.

IV. ASSIGNMENT OF RESPIRATORS

Each employee will be given his own respirators for their exclusive use. They are responsible for their respirators.

V. MAINTENANCE AND INSPECTION OF RESPIRATORS:

Respirators shall be routinely inspected before and after each use and during cleaning. All suspect parts shall be replaced and documented in the log book

Respirators will be cleaned and disinfected after each use. The employee will mark down each cleaning in the log book.

To clean and disinfect respirators, mix an ounce of bleach, some dishwater soap, and a gallon of water. Remove HEPA filters from the respirator. Immerse respirator in the solution and wipe clean.
Let respirator drip dry or wipe dry. **DO NOT** dry with hair dryer or other heat method.

VI. STORAGE

Respirators shall be stored in the sealable plastic bag and a box.
The employee should keep the box that the respirator came in. It is excellent place for storage.

VII. SURVEILLANCE

Each employee should monitor their work and others to insure that the respirators are being used properly. All negative observations should be noted in the log book and forwarded to the administrator.

Employees are warned that if the administrator finds an employee not using or purposely

damaging their respirator, the employee can be terminated from employment.

Since respirators are furnished to employees free from any charges, employees shall feel free to report and fix any damages to their respirators.

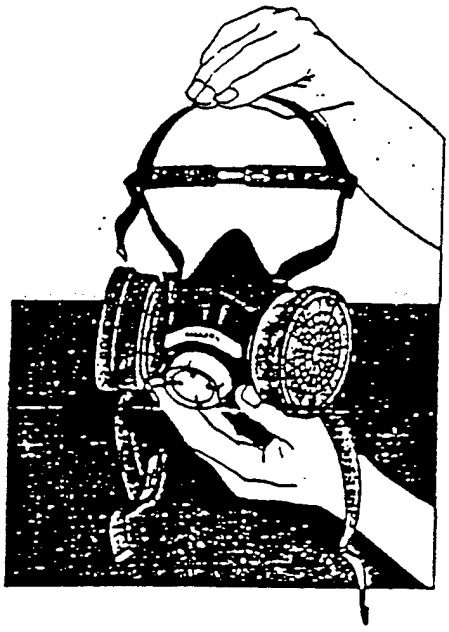
VIII. CERTIFICATION

All Respirators will be certified by either National Institute for Occupational Safety and Health (NIOSH) or the Mine Safety and Health Administration (MSHA).

DONNING AND FIT CHECK PROCEDURES

1.

Make sure the respirator is assembled correctly and is equipped with the proper filter and/or cartridge. Carefully study the use and fitting instructions supplied with the respirator. If you have any questions, talk to your supervisor.



2.

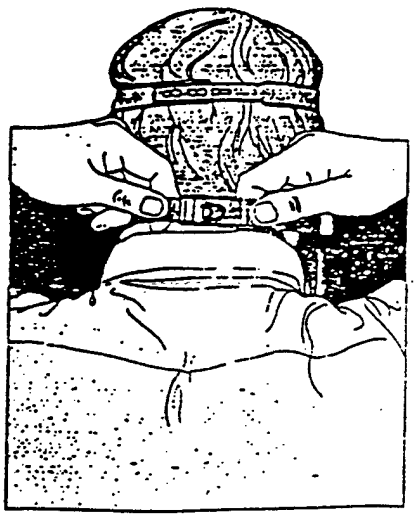
Remove protective eyeware. Place respirator under the chin and over the nose. The narrow part of the facepiece goes over the nose, as low as is comfortable.

3.

Pull the crown straps over the head and position them for comfort. The crown straps are adjustable for different head sizes.

4.

Hook the lower headband straps together behind the neck.



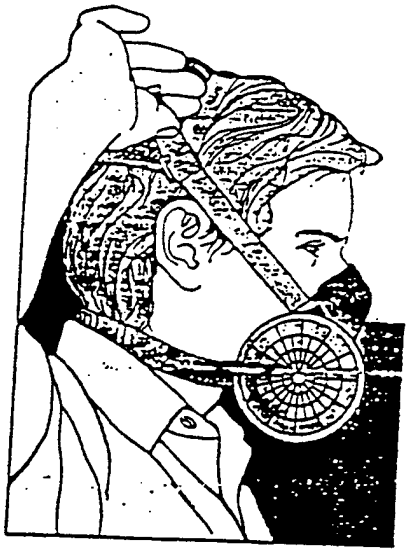
5.

Adjust the upper and lower headband straps until a comfortable fit has been achieved. DO NOT overtighten the respirator to the face.

6.

Secure the ends of the upper straps by using the clips molded into the crownstraps.

CAUTION: OSHA requires a respirator be inspected by the wearer before each use to insure it is in good working condition.



POSITIVE-PRESSURE FIT CHECK

To conduct a positive-pressure fit check, place heel of hand over the hole in the exhalation valve cover and exhale with sufficient force to cause a slight positive pressure inside the facepiece. If the facepiece bulges slightly and no air leaks between the face and facepiece are detected, a proper fit has been obtained. If air leakage is detected, reposition the respirator on the face, readjust the tension of the headbands, or try a different size respirator. Repeat the test until a satisfactory seal has been achieved.

NEGATIVE-PRESSURE FIT CHECK

To conduct a negative-pressure fit check, place palms of hands over the RP22 filter retainer/fit-check covers which have been attached. Inhale for five to ten seconds. If the facepiece collapses slightly and no air leakage between the facepiece and your face have been detected, a proper fit has been obtained. If air leakage is detected reposition the respirator on the face, adjust tension of the headbands, or try a different size respirator. Repeat the test until a satisfactory seal has been achieved.

WHAT YOU HAVE TO DO

After your employer gives you the respirator, you have to use it safely. Do you have the right one? Did you get a fit test on your respirator? Does your respirator work? Is is clean? You are the one who cares most about whether your respirator works. If it is not in perfect shape, you could breathe hazardous material. Learn how to use your respirator and take care of it.

Do you have the right respirator?

Does your respirator fit you? Do you have an approved respirator? Look for the MSHA/NIOSH seals on your respirator box and filters. You need to have the right respirator for the job. Look at the air samples and figure out which respirator you need. Is your respirator good enough?

Know how to use your respirator.

If you don't know how to use your respirator, it will not protect you. If you do not maintain it, it will not protect you. Get to know your respirator. Inspect your respirator. Are all the parts where they belong?

Inspect your respirator every time you use it.

A respirator can't help you unless it's in perfect shape. You need to inspect your respirator before you put it on. Make sure all the parts are there. Make sure all the parts are in good shape and in the right place. If you find anything wrong with your respirator, **do not wear it until it is fixed.**

Keep your respirator clean.

Though respirators are never comfortable, they can become very uncomfortable if you do not clean and disinfect them regularly. It is very easy to clean your respirator and you must clean it every time you use it.

Store your respirator in a safe place.

Don't hang your respirator by the straps to dry. Keep your respirator in a clean, dry place. It is easy to damage a respirator by improper storage.

Appendix F - Waste Collection Plan

Power Environmental Abatement Technologies

Waste Collection Plan

Kelly Air Force Base, Texas

1. INTRODUCTION

Power Environmental Abatement Technologies (PEAT) will implement the following plan to dispose of all waste and lead contaminated waste from lead paint removal operation at Kelly AFB.

2. WASTE COLLECTION

PEAT will store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55-gallon drums. It is estimated that (unknown at this time) drums of hazardous lead contaminated waste will be produced.

PEAT will label each drum to identify the type of waste (49 CFR 172) and date the drum when filled. PEAT will handle, manage, store and transport the drum to an interim storage area to be identified by the Kelly AFB EM/CE. Labels will be provided by the Kelly Hazardous Waste Team.

Lead contaminated waste is expected to include, but is not limited to, protective clothing, towels, respirator cartridges, air filtration filters, and cleaning supplies.

All lead contaminated hazardous waste inside the containment will be inserted into plastic bags and sealed or will be wrapped in plastic and sealed with tape before leaving the containment.

PEAT will collect samples of lead paint waste for TCLP testing as determined by the USACERL representative and Kelly EM/CE.

3. WASTE DISPOSAL

PEAT will dispose, handle, manage, store, and transport all lead contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Peat will comply with land disposal restriction notification requirements as required by 40 CFR 268.

PEAT shall be responsible for the disposal of all waste created on this project in accordance with all local, state and federal regulations. PEAT shall manifest the waste through the Kelly Hazardous Waste Team prior to disposal in a TNRCC/EPA approved landfill.

Appendix G - Worker Protection Plan

Power Environmental Abatement Technologies

Worker Protection Plan

Kelly Air Force Base, Texas

1. INTRODUCTION

Power Environmental Abatement Technologies (PEAT) will institute the following plan to protect its employees from any hazards while performing lead based paint removal at Kelly AFB.

2. RIGHT-TO KNOW NOTICES

PEAT will provide to its employees all Right-To-Know notices and will provide on-site posting of these Right-To-Know documents. These notices will comply with 29 CFR 1910.1200.

These Right-To-Know notices will include all appropriate manuals, lists, files, and MSDS sheets for any equipment, paint, material, chemical paint stripper, cleaning chemical and any other product that PEAT will use to complete the contracted work.

PEAT will also post all State, Local, and Federal Government requirements including US Department of Labor, OSHA, Workmen Compensation Insurance, and Unemployment Insurance standards.

3. RESPIRATOR PROTECTION PROGRAM

PEAT provides all employees with one full-face and one half-face respirator. PEAT provides all HEPA and/or organic vapor cartridges for the respirators which are changed after eight (8) hours of use.

Each employee has been medically cleared and has been fit-tested to wear their respective respirators.

All respirators have been approved by MSHA (Mine Safety and Health Administration), NIOSH (National Institute for Occupational Safety and Health), and Department of Health and Human Services.

4. MEDICAL SURVEILLANCE

Each PEAT employee is under an outside medical surveillance program. This program includes lead blood and ZPP level sampling and analysis, pulmonary testing,

detailed work history, and exposure assessment. All lab testing is done at OSHA approved facilities.
The medical surveillance program is instituted at:

Union Occupational Health Center
450 Grider St.
Buffalo, NY 14215-3019

5. WORKER TRAINING

All PEAT employees are properly trained in the following areas:

A. Respirator face fitting and cleaning.
B. Protective clothing fitting and sealing.
C. Procedures for entering/exiting containment.
D. Personal Hygiene and cleaning.

6. PROTECTIVE CLOTHING AND EQUIPMENT

PEAT will provide an adequate supply of protective clothing and supplies to insure workers safety and to reduce workers exposure to lead paint particles. PEAT will also have a sufficient supply of these items for any authorized visitors and or Department of Defense Personnel.

The list of these items include, but are not limited to, coveralls, boots, gloves, hard hats, respirators, HEPA cartridges, face shields, eye goggles, and any other items PEAT deems necessary to protect its workers.

All disposable protective clothing will be plastic bagged or plastic wrapped then sealed before leaving containment and disposed of as lead contaminated waste. All reusable clothing will be sealed and washed according to 29 CFR 1926.62.

All reusable protective equipment will be washed with Ledisolv or like solution after each day of use.

7. SIGNS

PEAT will provide signs warnings workers that they are entering a lead paint hazard area. The sign will read:

DANGER

LEAD ABATEMENT

BRAIN, LIVER, KIDNEY, AND BLOOD HAZARD

AUTHORIZED PERSONNEL ONLY

RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

8. PERSONAL HYGIENE

PEAT will provide an eating area, clothes changing area, washing area, and bathroom facilities for its employees. All soaps, towels, water, and other hygiene supplies and equipment will be provided by PEAT. All employees will properly wash themselves before leaving containment, eating, drinking, and smoking.

9. EMERGENCY POSTING

PEAT will post a list of telephone numbers of the local hospital/emergency squad, the local police department, the local fire department, Power Environmental Abatement Technologies' local and corporate offices, and US government official who can be reached 24 hours a day and any other individual or company involved with this project.

10. SPECIAL EQUIPMENT

PEAT will use two (2-3) air filtration units. Each unit will reduce the amount of airborne dust particles inside the containment resulting in a lower PEL (personal exposure level). Air will be removed from the containment through three (3) filters. Air will pass first through a primary filter, then a secondary filter and finally through a HEPA filter before exiting the containment. Each unit can move 2,500 CFM (cubic feet per minute).

11. OSHA 29 CFR 1926

PEAT will comply with these standards.

12. CERTIFICATION

PEAT will provide workers who have been trained to work in lead paint removal environment. PEAT will subcontract with RCI Environmental to provide all air monitoring and a Certified Industrial Hygienist (CIH) to monitor PEAT's work practices and worker protection procedures and programs.